CS-23

Hog Island Gully, West Cove & Headquarter Canal Structure Replacement Summary Data and Graphics

10/01/2003

Miller, M. 2003. *CS-23 Hog Island Gully, West Cove & Headquarters Canal Structure Replacement Summary Data and Graphics, Louisiana Department of Natural Resources, Coastal Restoration Division, Baton Rouge, Louisiana. 52pp.*

Hog Island Gully, West Cove & Headquarters Canal Structure Replacement (CS-23)

Project Overview:

The Replace Hog Island Gully, West Cove and Headquarters Canal Structures (CS-23) project area is located within the Sabine National Wildlife Refuge, approximately 9 mi (14.5 km) south of the town of Hackberry in Cameron Parish, Louisiana (figure 1). Established on December 6, 1937, the Sabine Refuge is bound on the east by Calcasieu Lake, on the west by Sabine Lake, on the north by broken marsh, and on the south by pasture land and coastal ridges.

O'Neil (1949) characterized the project area wetlands as fresh to intermediate marshes dominated by *Cladium mariscus* (Jamaica sawgrass). The Black Lake area, located north of the project, experienced an 81% reduction in the acreage of emergent wetlands between 1952 and 1974 (Adams et al. 1978). By 1972, the Black Lake area was characterized as brackish marsh (Chabreck and Linscombe 1978). A number of factors such as salinity stress, erosion, subsidence, burning and hydrologic modification influenced this habitat change.

Since there are primarily three avenues for water passage (Hog Island Gully, West Cove Canal, and Headquarters Canal) in the area, the feasibility of water management by weirs was investigated in the 1970's. These structures had corroded with the continuous exposure to saline water to the extent that they were inoperable or almost inoperable.

Due to the detrimental impacts of excessive salinity on brackish and intermediate marshes, the ability to occasionally reduce or halt the inflow of saline water is critical. This level of control was not available with the existing structures. The inability to manipulate gate structures jeopardized the integrity of thousands of acres of interior brackish and intermediate marshes which are lower in elevation and often occur in highly organic semifloating soils. The estimated subsidence rate in the project marshes ranges between 0.12 in/yr and 0.16 in/yr (0.32 and 0.42 cm/yr) (Penland et al. 1989).

Hog Island Gully, West Cove & Headquarters Canal Structure Replacement (CS-23)

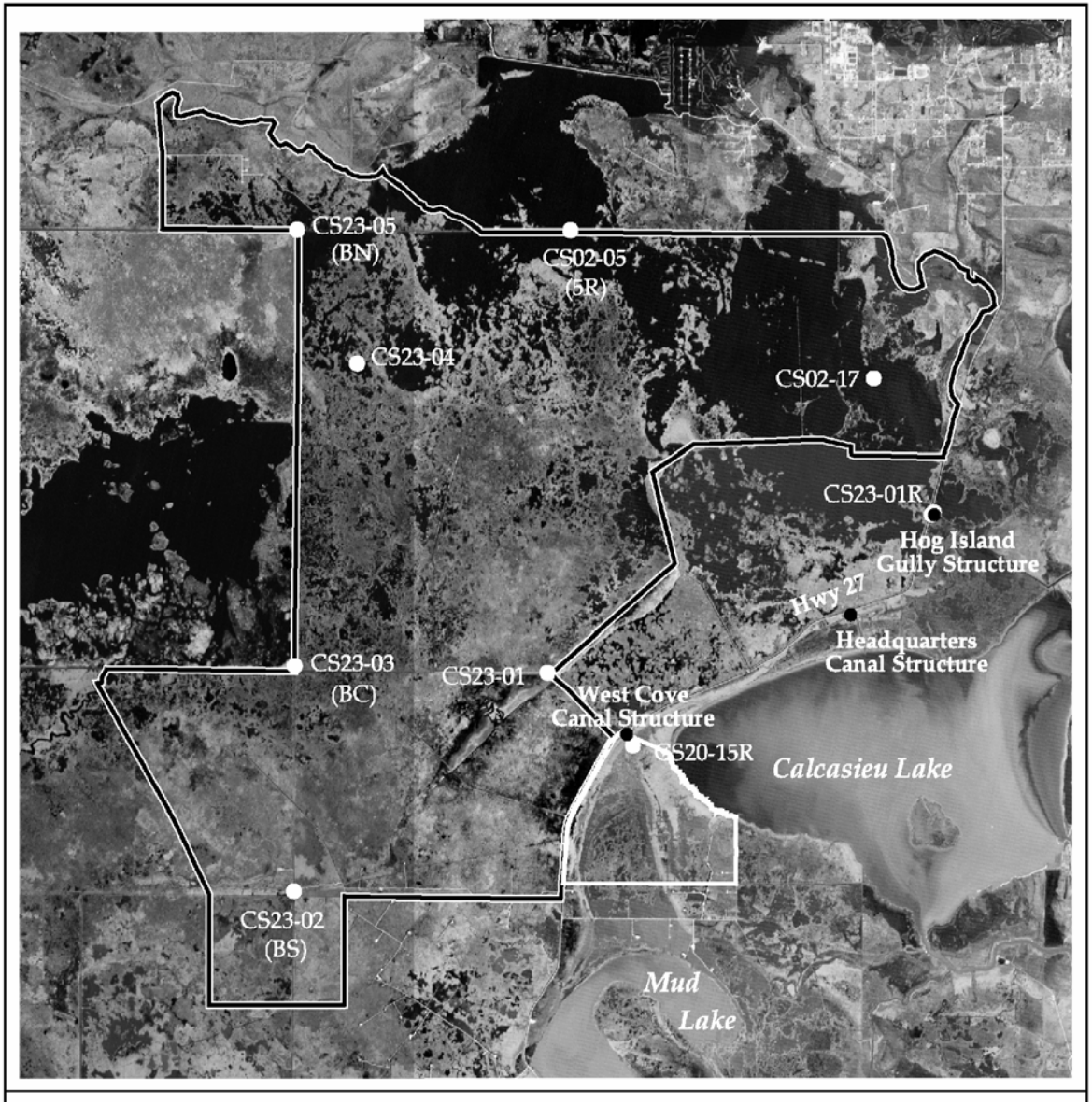
Project Overview: (continued)

Because of the restricted cross-sectional area of the pre-existing structures and culverts, the lower elevation interior marshes experienced longer periods of vegetative water logging stress than the marshes located east of Highway 27. The pre-existing structures afforded the primary avenues for drainage and were inadequate to provide sufficient discharge to evacuate excess water. Due to the project area not being fully enclosed, secondary drainage for the area could occur to the west through Sabine Lake via North, Central and South line canals.

In September 1996, the USFWS began development of the draft environmental assessment (EA) plan addressing the Replacement of Water Control Structures at Hog Island Gully, West Cove Canal, and Headquarters Canal (CS-23). The plan called for the complete removal of the Hog Island Gully Structure, West Cove Canal Structure, and Headquarters Canal Structure and replacement with additional structures and culverts to provide larger cross sections for water removal and to minimize saltwater intrusion.

The replacement structures are operated to more effectively discharge excess water, increase cross sectional area for ingress/egress of estuarine dependent species and more effectively curtail saltwater intrusion into the interior marshes. Since completion of the new structures, high saline waters could be precisely controlled, water discharge capacities have been increased, and vegetative stress through water logging has been minimized, thus enhancing emergent and submergent vegetative growth.

Construction began in November 1999 and was completed on the Hog Island Gully, West Cove, and Headquarters Canal structures in August 2000, June 2001, and February 2000, respectively. However, the Hog Island Gully and West Cove structures were not fully operational due to an electrical service problem until October 2003.



CS-23 Boundary

Reference Area

Continuous Recorders

Water Control Structures

Figure 1. Replace Hog Island Gully, West Cove and Headquarters Canal Structures (CS-23) project features, project area boundaries and reference area boundaries.

Hog Island Gully, West Cove & Headquarters Canal Structure Replacement (CS-23)

- **Project Objective**

  1. Increase the cross-sectional area of the project features to improve hydrologic conditions that control high saline waters, increase water discharge capacities, and maintain emergent vegetation.

- **Specific Goals**

  1. Reduce the occurrence of salinities that exceed target levels at stations CS23-02 (BS), CS23-03 (BC), CS23-05 (BN) and CS02-05 (5R).
  2. Minimize frequency and duration of marsh flooding events.
  3. Maintain existing intermediate and brackish vegetation communities.
  4. Increase occurrence of submerged aquatic vegetation (SAV).

Hog Island Gully, West Cove & Headquarters Canal Structure Replacement (CS-23)

Monitoring Elements:

The following monitoring elements will provide the information necessary to evaluate the specific goals listed above:

Aerial Photography: To document land and water acreage and land loss rates in the hydrologic unit, reference area, and whole project area, color infrared aerial photography (1:12,000 scale with ground controls) of the project and reference areas will be obtained. The photography will be georectified by National Wetlands Research Center (NWRC) personnel following procedures described in Steyer et al. (1995), but detailed photo interpretation, mapping, and GIS is not planned. The photography was obtained prior to construction in 2000 and will be obtained after construction in years 2004, 2009, and 2018.

Salinity: Salinities are monitored hourly utilizing nine continuous recorders. Six are located in the project area, two in the reference area and one outside of the project area within Hog Island Gully Canal. Six recorders are associated with this project, two associated with Rycade Canal (CS02-05, CS02-17) and one from East Mud Lake (CS20-15R). Discrete salinities are being collected bi-weekly at 15 stations in the project and reference areas by USFWS and are provided to DNR each month. Both discrete and continuous data will be used to characterize frequency and duration of average annual salinities throughout the project and reference area. Salinity data will also be used to identify occurrences of salinities that exceed target levels at stations CS23-02 (BS), CS23-03 (BC), CS23-05 (BN) and CS02-05 (5R). Salinity was monitored in 1998-1999 (preconstruction) and will be monitored from 2000-2018 (postconstruction).

Water Level: To document annual duration and frequency of flooding, water levels are monitored hourly at continuous recorder stations located in the project and reference area sites. A staff gauge has been surveyed adjacent to each continuous recorder to correlate water levels to a known datum. Marsh elevations have been established at stations (CS23-02, CS23-03, CS23-05, CS02-05, CS02-17, CS20-15R) and will be used to evaluate 1998-1999 (preconstruction) and 2000-2018 (postconstruction) data sets.

Hog Island Gully, West Cove & Headquarters Canal Structure Replacement (CS-23)

Monitoring Elements, Cont:

Vegetation: Species composition, richness and relative abundance will be evaluated in the project and reference areas using the Braun-Blanquet method as described in Steyer et al. (1995). Fifty $4m^2$ sample areas (replicate 2m x 2m plots) are used to monitor percent cover, species composition, and height of dominant plants. Forty plots are located in the project area and ten existing plots are in the reference area. The plots were established along a North/South transect line and are marked by GPS points and PVC poles to allow revisiting over time. Vegetation was monitored once in 1999 (preconstruction) and will be re-sampled in years 2004, 2009, 2014, and 2018.

Submerged Aquatic Vegetation: To determine the occurrence of submerged aquatic vegetation (SAV) within the project and reference area, eight ponds are randomly sampled for presence or absence of SAV using the modified rake method (Nyman and Chabreck1996). Five ponds are located in the project area and three in the reference area. Transect lines are set up within each pond and a minimum of 25 samples are taken along each transect line, not to exceed 100 samples per line. Depending on pond configuration and wind direction, the number of transect lines within each pond varies. SAV's were monitored in 1999 (preconstruction) and will be sampled in years 2004, 2009, 2014, and 2018.

Hog Island Gully, West Cove & Headquarters Canal Structure Replacement (CS-23)

Aerial Photography

Aerial photography was collected in 1999. It will also be collected in 2004, 2009 and 2018. The 1999 Land/Water analysis is currently being processed by the NWRC.

- **Figure 2.** 2000 photo-mosaic of the Hog Island Gully, West Cove and Headquarters Canal Structure Replacement project area.

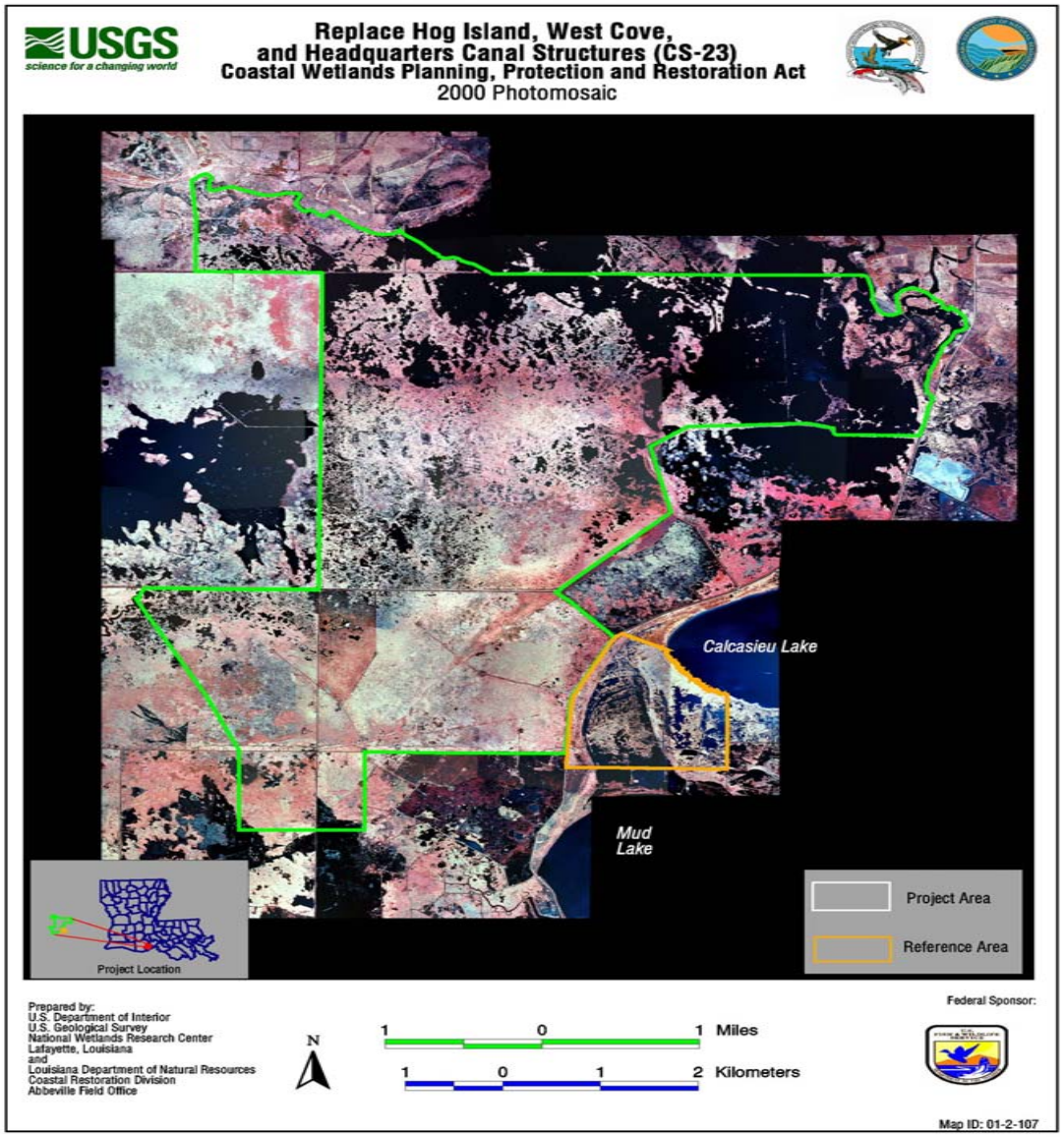


Figure 2. 2000 photo-mosaic of the Hog Island Gully, West Cove and Headquarters Canal Structure Replacement project area.

Hog Island Gully, West Cove & Headquarters Canal Structure Replacement (CS-23)

Salinity and Water Level Data

- Collected Hourly at 5 stations 1997 to present.
- **Figures and Tables:**
- **Figure 3.** 1998 DOQQ imagery of continuous recorder monitoring stations in the Hog Island Gully, West Cove and Headquarters Canal Structure Replacement project and reference areas.
- **Table 1.** Pre and Post construction flood and drain frequencies for stations CS23-02, CS23-03, CS23-05 and CS23-1R from 1997 to present.
- **Figure E1 – E16.** Hourly Salinity and Water Level Data by station (english)
- **Figure M1 – M16**. Hourly Salinity and Water Level by station (metric)
- **Table 2.** Least square means of adjusted salinity and water level data from 1998 – 2002.

Figure 3. 1998 DOQQ imagery of continuous recorder monitoring stations in the Hog Island Gully, West Cove and Headquarters Canal Structure Replacement project and reference areas.

Hog Island Gully, West Cove and Headquarter Canal Structure Replacement (CS-23)

Pre and Post Construction Yearly Water Level Comparisons from 1997 – 2002.

	Station 02				Station 03			
	Pre-Construction		Post-Construction		Pre-Construction		Post-Construction	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
FLOOD DEPTH								
0.01 to 0.5 ft	7751	90.73	5950	73.47	4345	85.21	3380	90.73
0.51 to 1.0 ft	758	8.87	1690	20.87	475	9.32	780	8.87
Above 1.0 ft	34	0.40	459	5.67	279	5.47	25	0.40
Total	**8543**	**100.00**	**8099**	**100.00**	**5099**	**100.00**	**4185**	**100.00**
DRAIN DEPTH								
0.0 to -0.49 ft	13667	80.53	2874	99.07	15068	68.66	5497	87.99
-0.5 to -.99 ft	3184	18.76	27	0.93	6486	29.55	750	12.01
-1.0 to -1.49 ft	120	0.71	0	0.00	393	1.79	0	0.00
-1.5 to -1.99 ft	0	0.00	0	0.00	0	0.00	0	0.00
below -2.0 ft	0	0.00	0	0.00	0	0.00	0	0.00
Total	**16971**	**100.00**	**2901**	**100.00**	**21947**	**100.00**	**6247**	**100.00**

	Station 05				Station 1R			
	Pre-Construction		Post-Construction		Pre-Construction		Post-Construction	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
FLOOD DEPTH								
0.0 to 0.5 ft	3305	85.89	3768	73.61	3673	80.92	3260	83.65
0.5 to 1.0 ft	269	6.99	1195	23.34	685	15.09	590	15.14
Above 1.0 ft	274	7.12	156	3.05	181	3.99	47	1.21
Total	**3848**	**100.00**	**5119**	**100.00**	**4539**	**100.00**	**3897**	**100.00**
DRAIN DEPTH								
0.0 to -0.5 ft	10298	52.68	5909	81.39	8543	44.40	4788	52.59
-0.5 to -1.0 ft	8174	41.81	1351	18.61	7166	37.24	2956	32.47
-1.0 to -1.5 ft	992	5.07	0	0.00	2751	14.30	1108	12.17
-1.5 to -2.0 ft	85	0.43	0	0.00	695	3.61	232	2.55
below -2.0 ft	0	0.00	0	0.00	87	0.45	21	0.23
Total	**19549**	**100.00**	**7260**	**100.00**	**19242**	**100.00**	**9105**	**100.00**

Table 1. Pre and Post construction flood and drain frequencies, # of hours and % of total for stations CS23-02, CS23-03, CS23-05 and CS23-1R from 1997 to present.

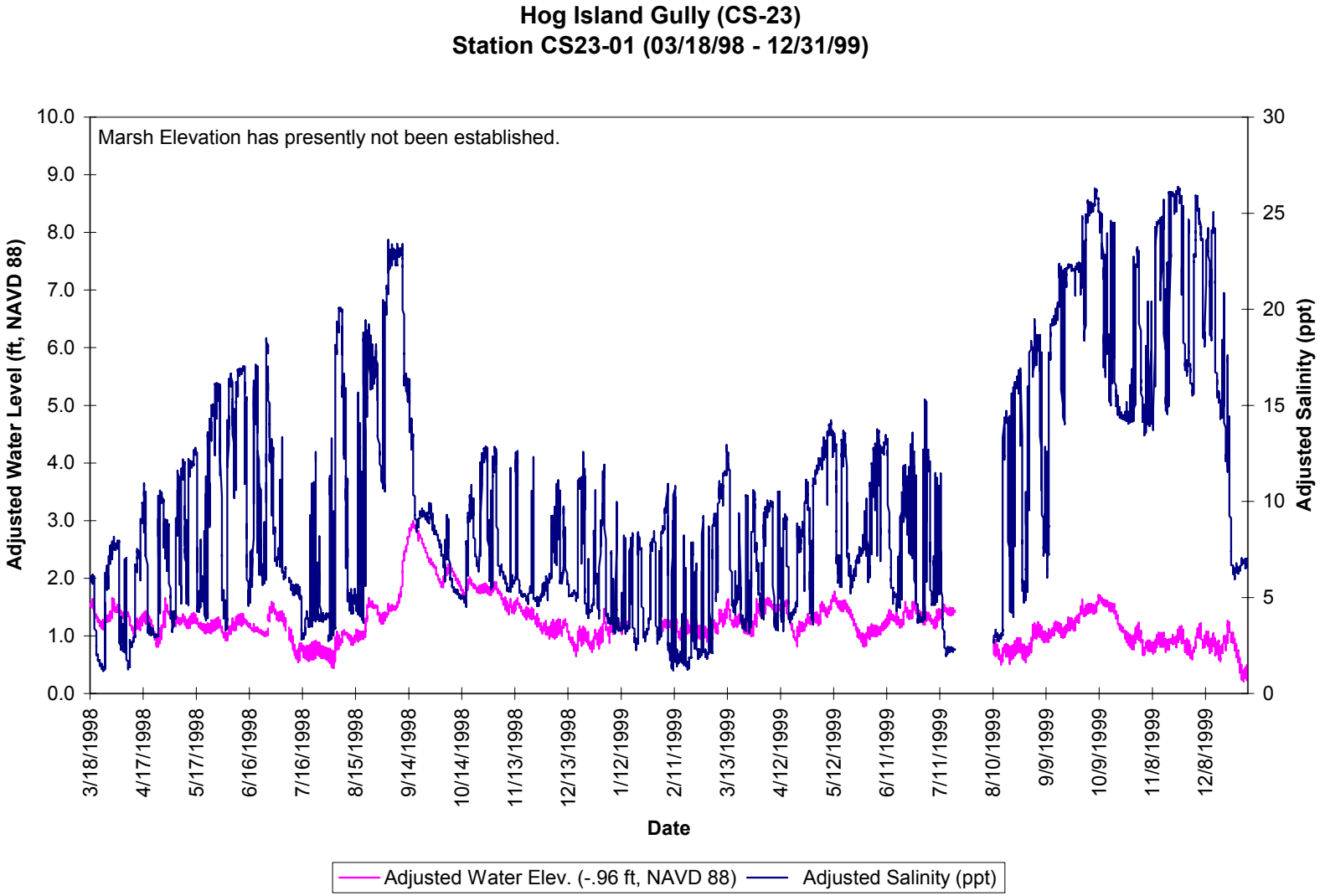


Figure E1. Salinity and water level data from station CS23-01 in (feet) from 3/18/98 to 12/31/99.

ENGLISH units

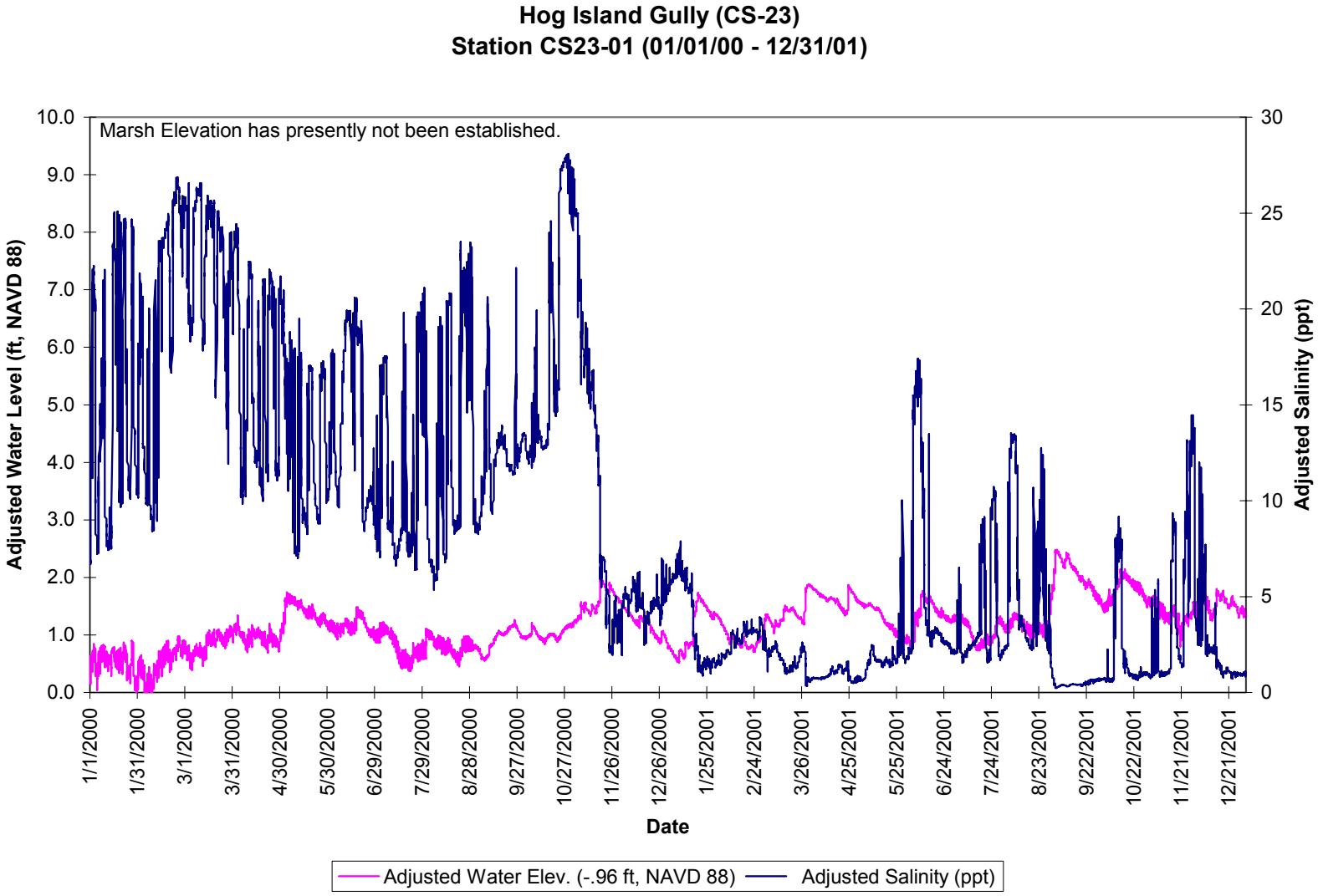


Figure E2. Salinity and water level data from station CS23-01 in (feet) from 01/01/00 to 12/31/01.

ENGLISH units

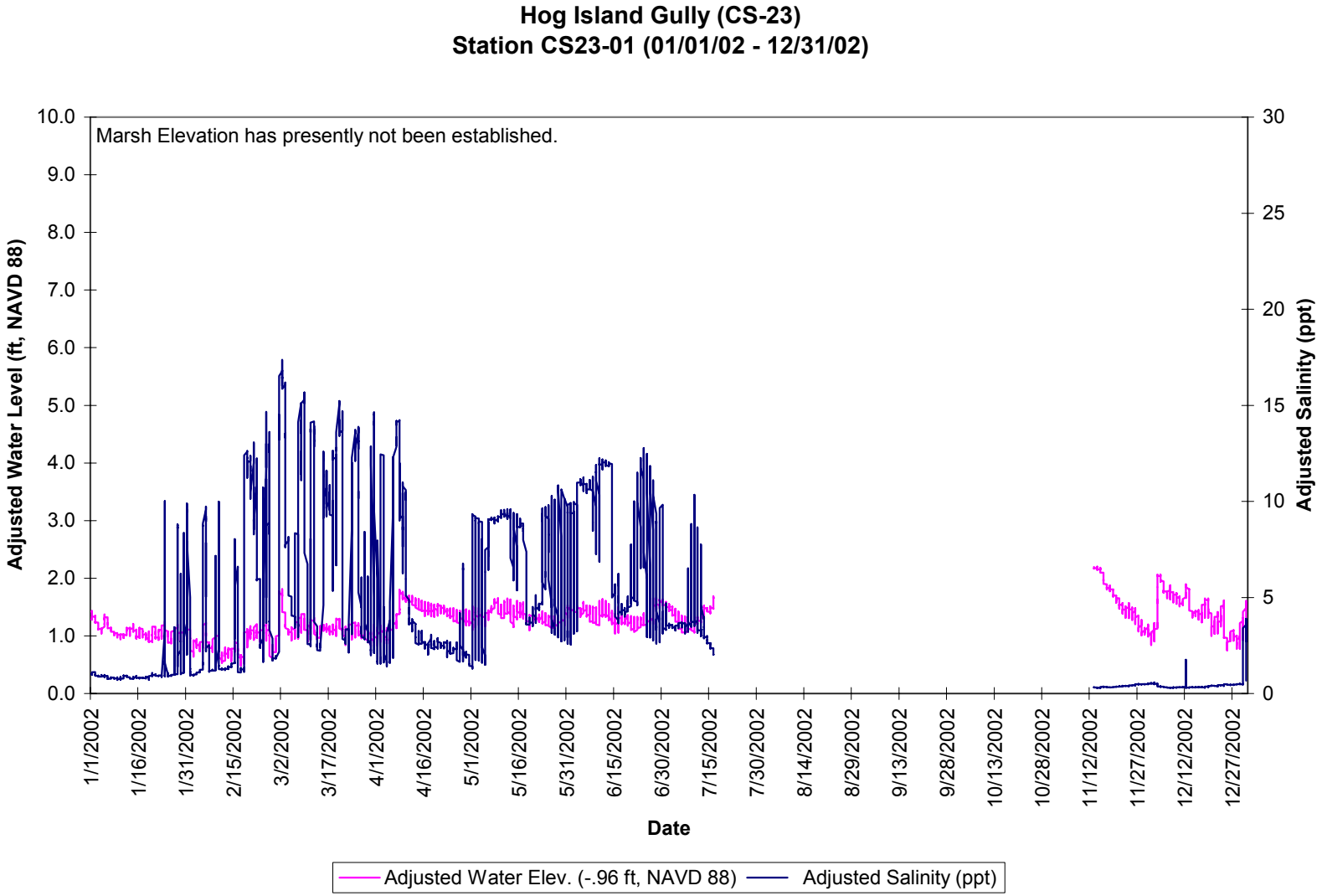


Figure E3. Salinity and water level data from station CS23-01 in (feet) from 01/01/02 to 12/31/02.

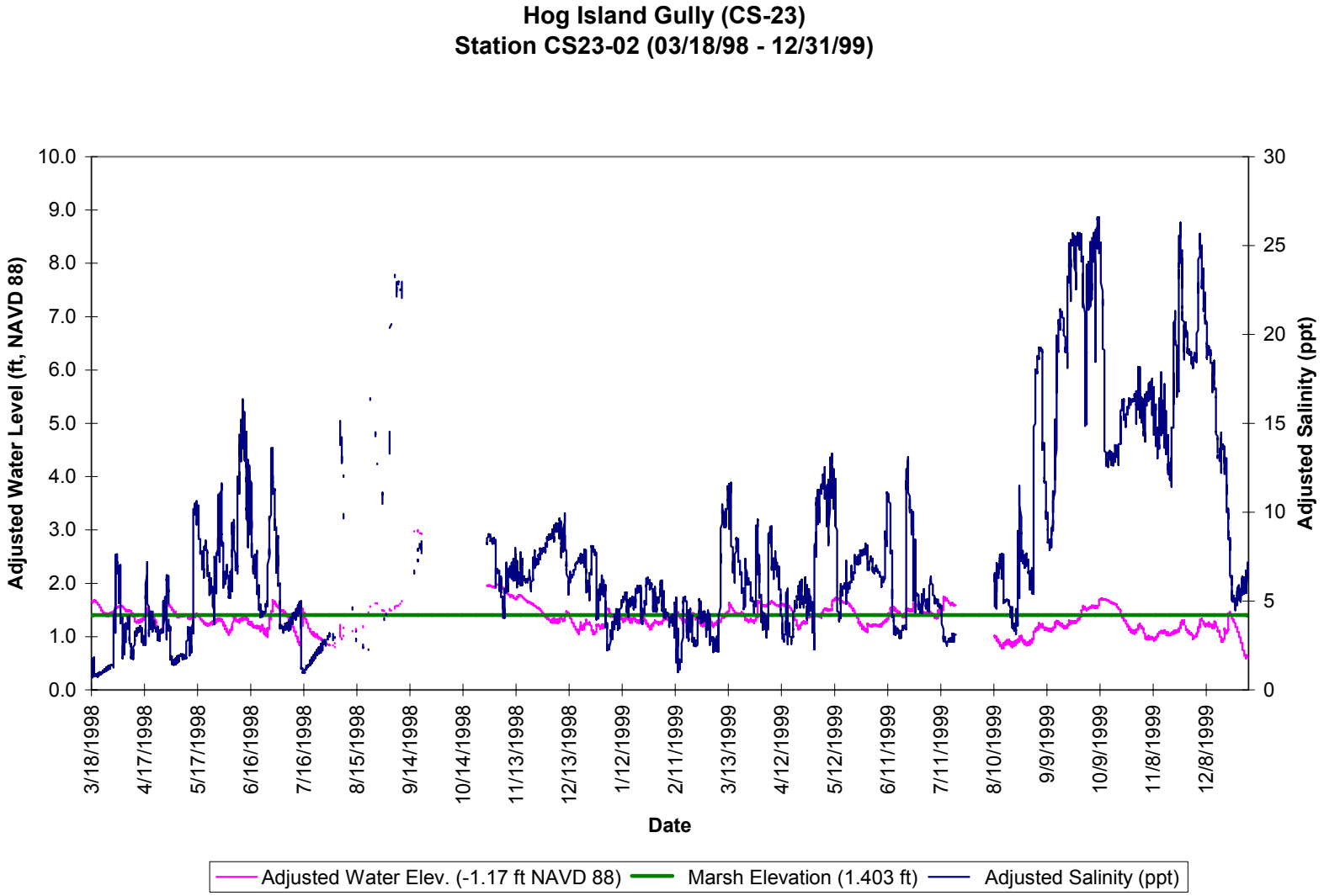


Figure E4. Salinity and water level data from station CS23-02 in (feet) from 03/18/99 to 12/31/99.

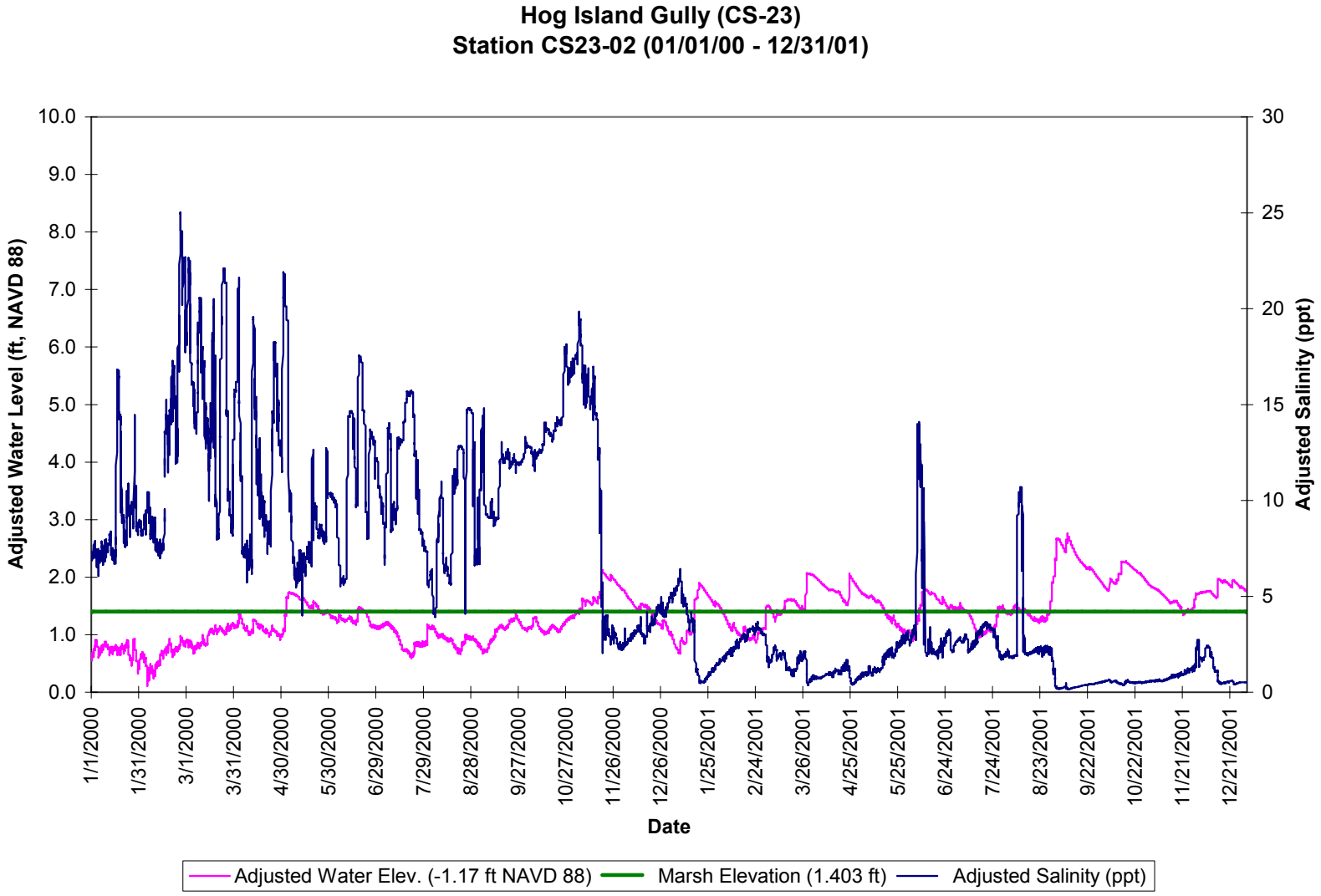


Figure E5. Salinity and water level data from station CS23-02 in (feet) from 01/01/00 to 12/31/01.

ENGLISH units

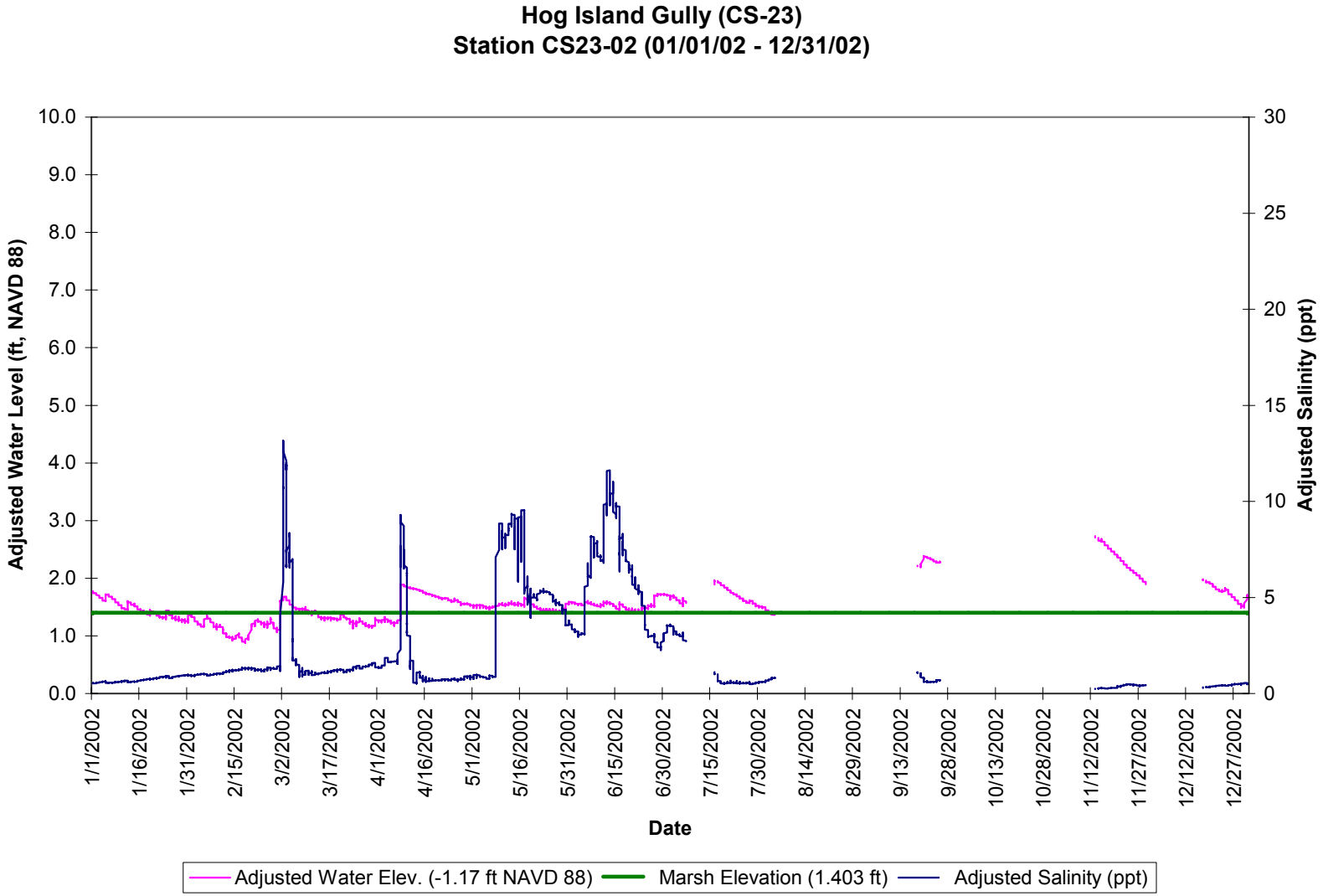


Figure E6. Salinity and water level data from station CS23-02 in (feet) from 01/01/02 to 12/31/02.

ENGLISH units

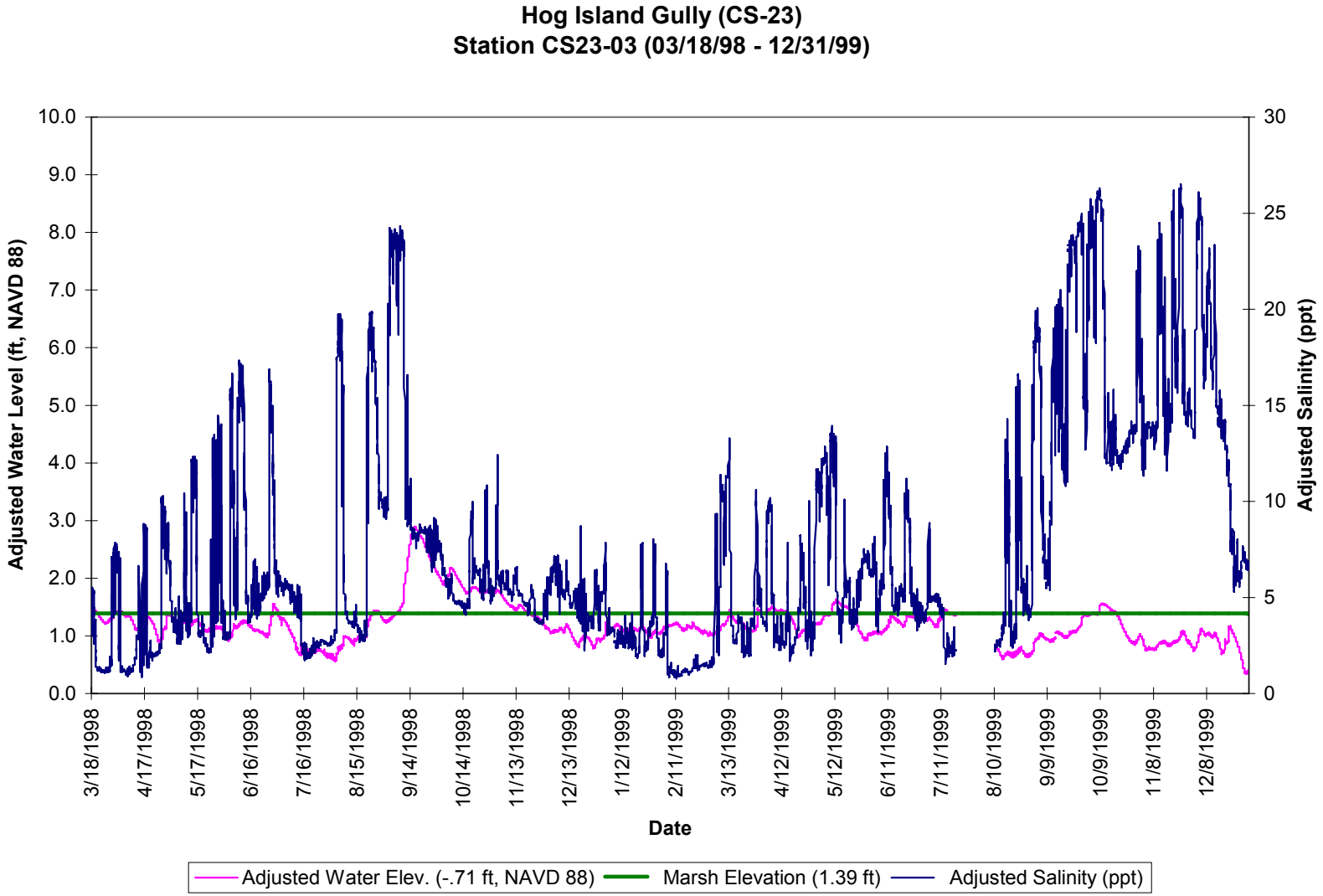


Figure E7. Salinity and water level data from station CS23-03 in (feet) from 03/18/98 to 12/31/99.

ENGLISH units

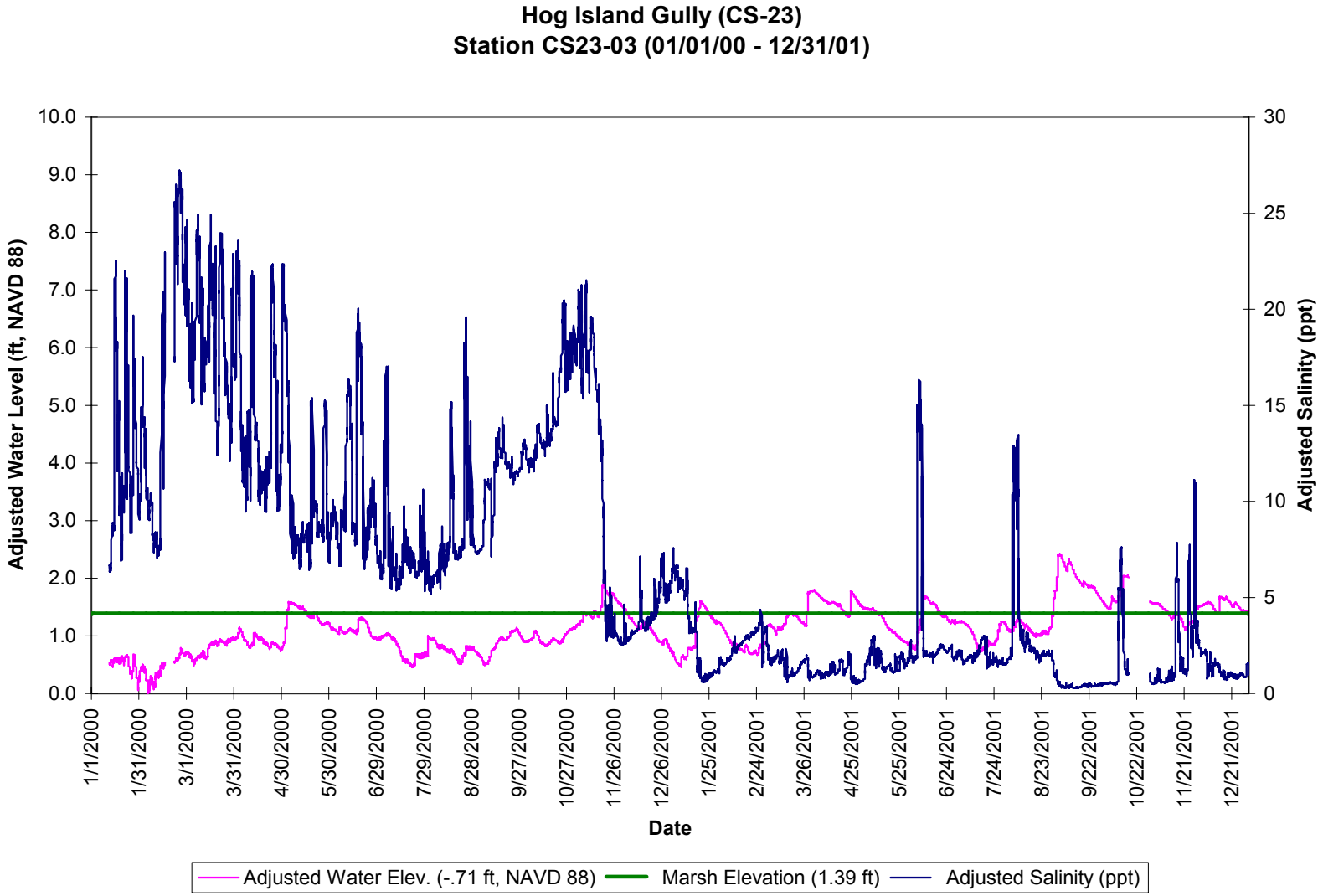


Figure E8. Salinity and water level data from station CS23-03 in (feet) from 01/01/00 to 12/31/01.

ENGLISH units

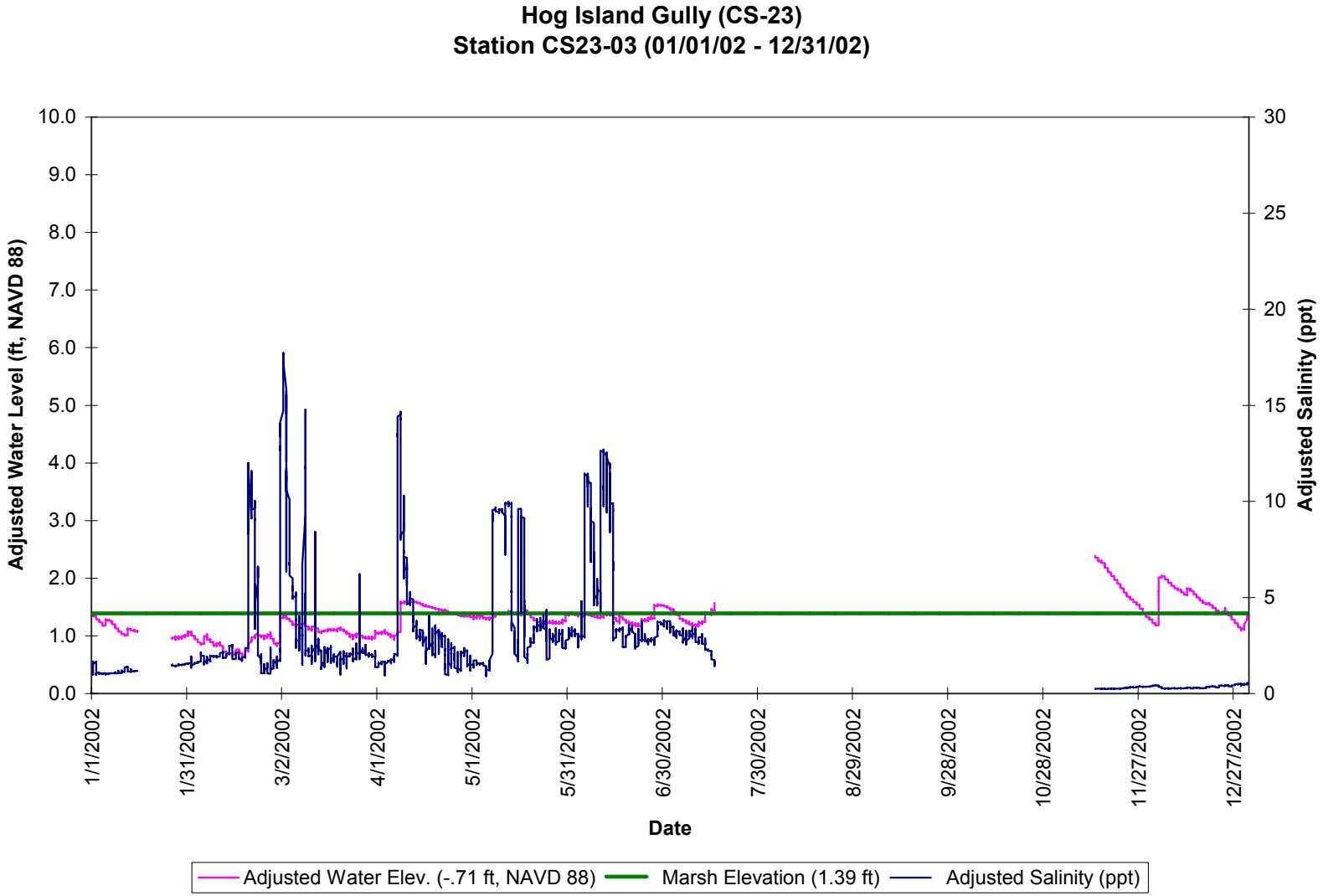


Figure E9. Salinity and water level data from station CS23-03 in (feet) from 01/01/02 to 12/31/02.

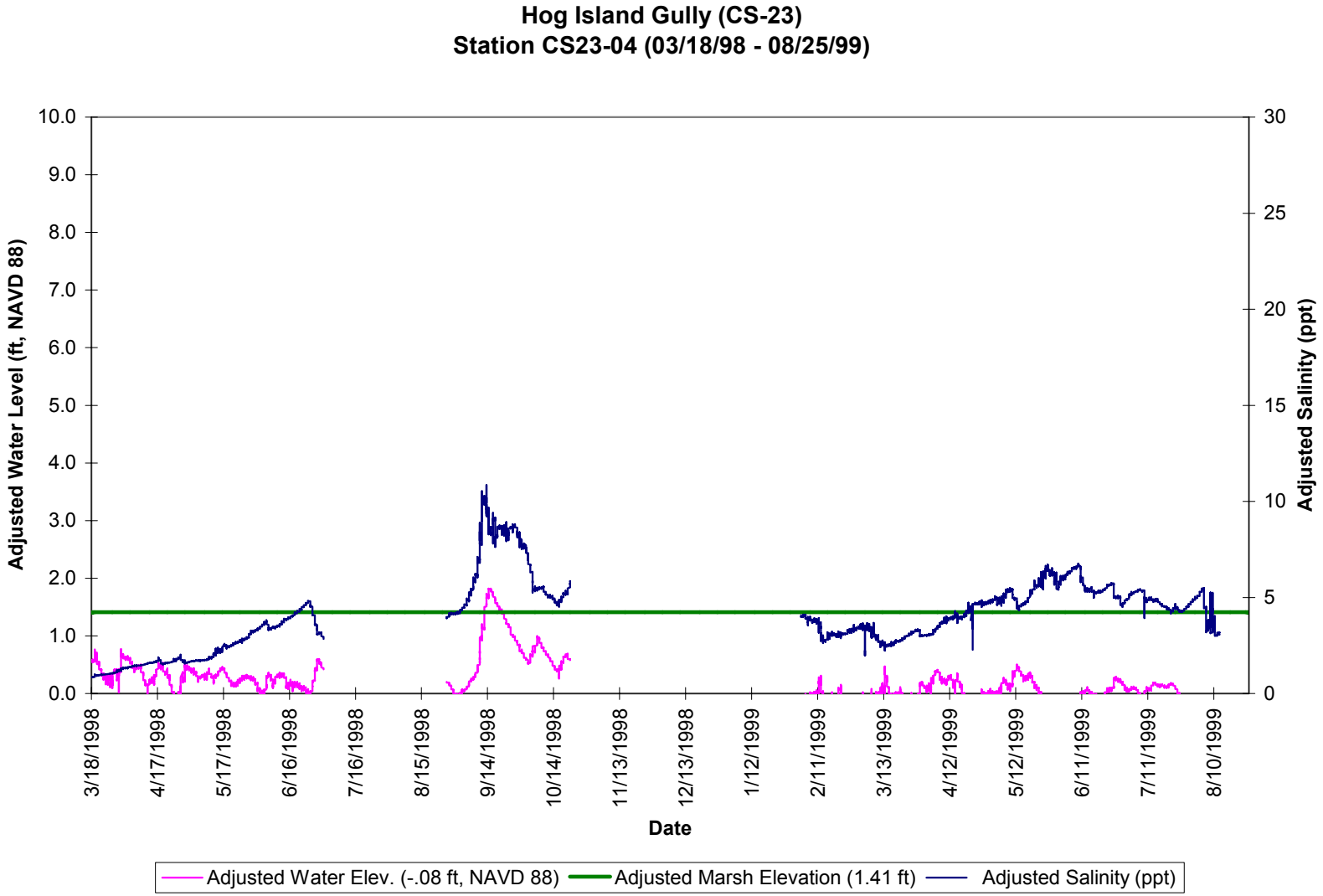


Figure E10. Salinity and water level data from station CS23-04 in (feet) from 03/18/98 to 08/25/99.

ENGLISH units

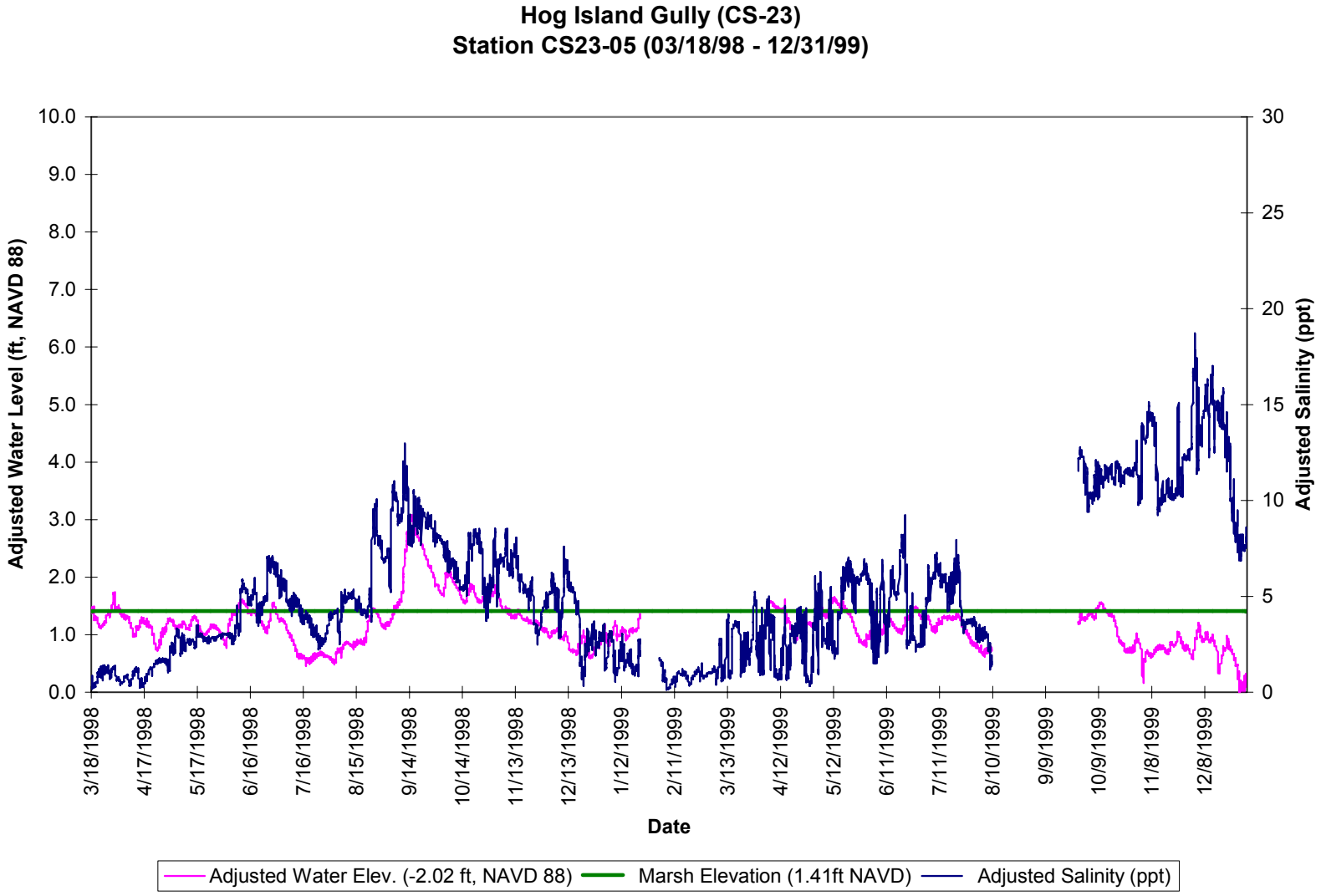


Figure E11. Salinity and water level data from station CS23-05 in (feet) from 03/18/98 to 12/31/99.

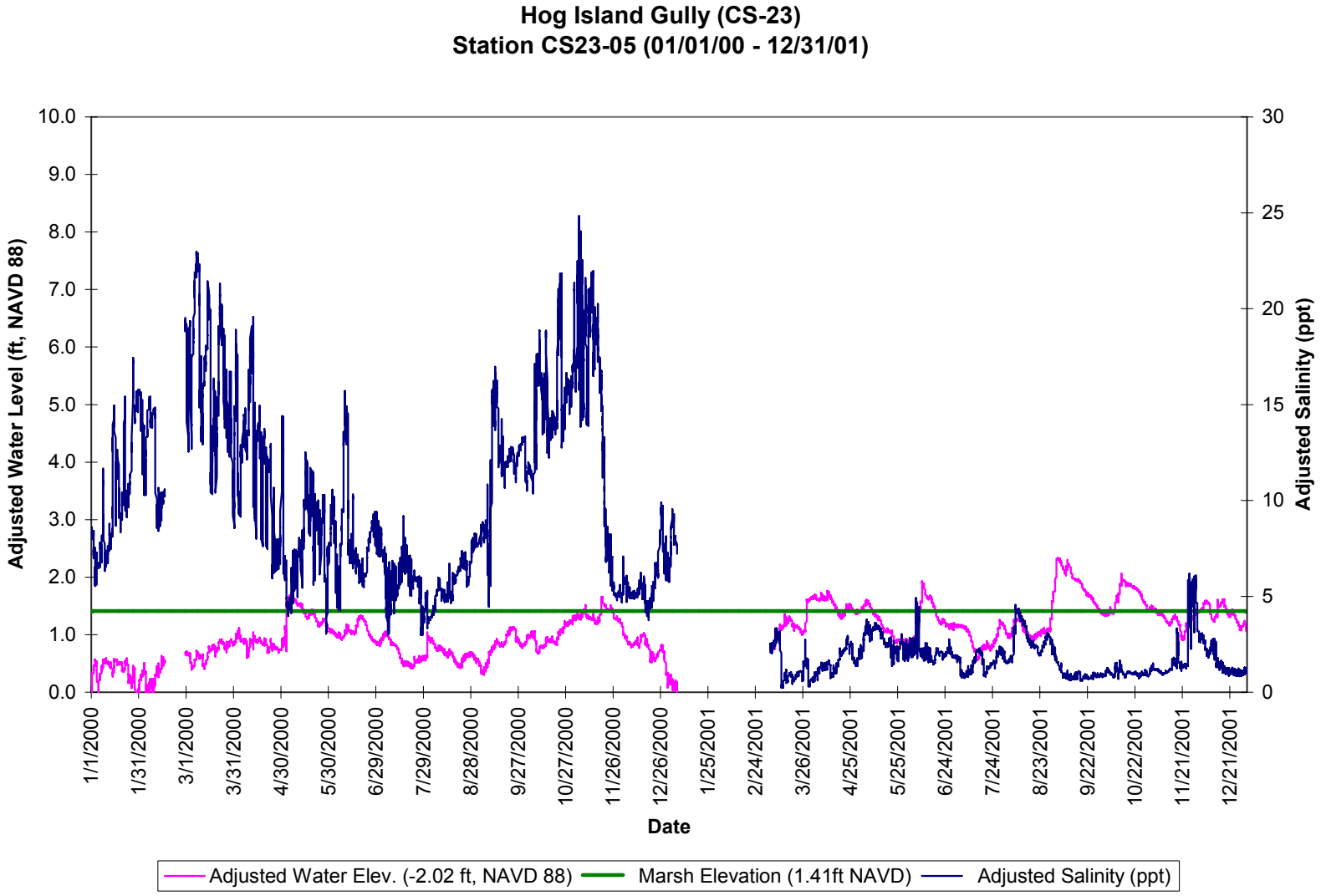


Figure E12. Salinity and water level data from station CS23-05 in (feet) from 01/01/00 to 12/31/01.

ENGLISH units

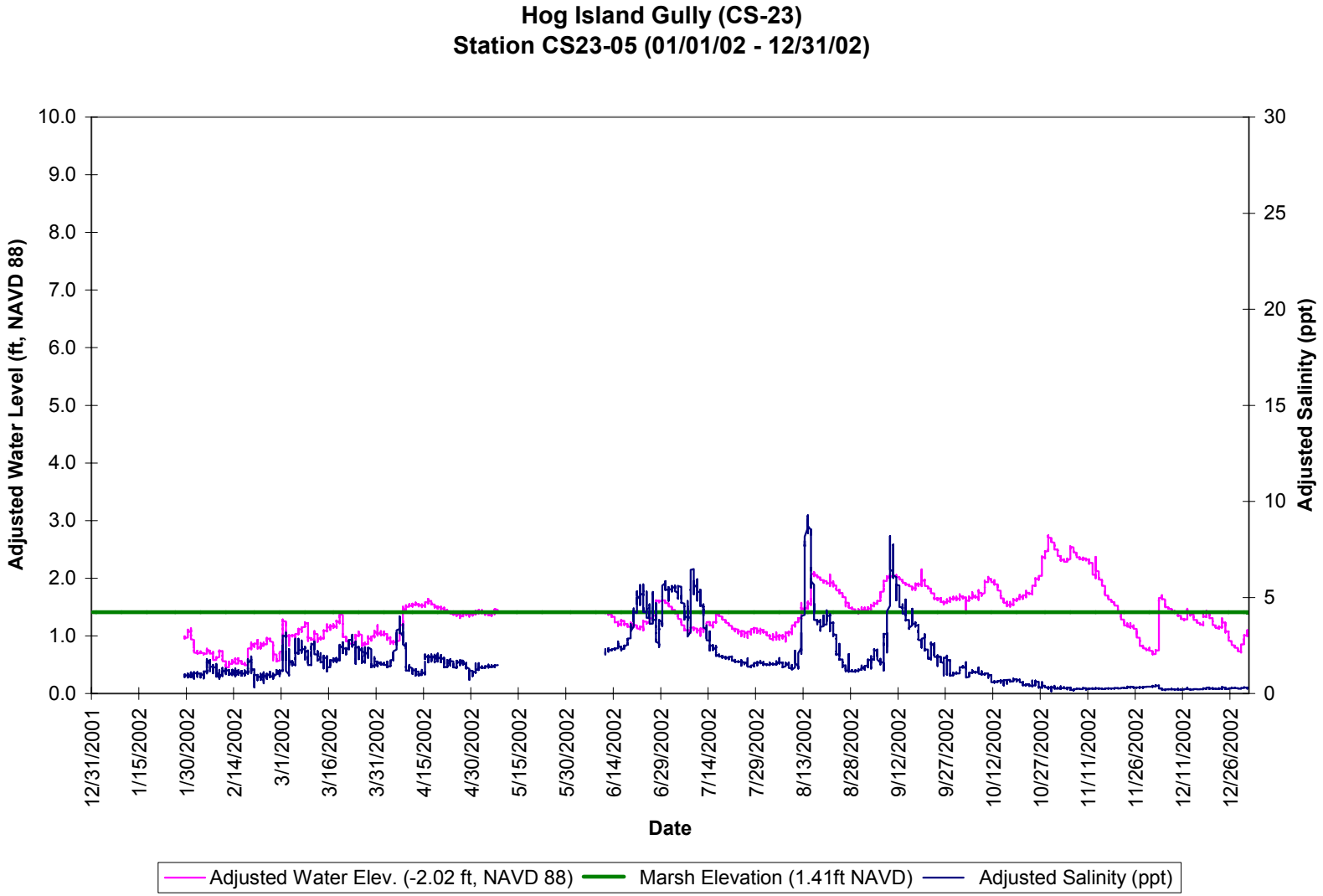


Figure E13. Salinity and water level data from station CS23-05 in (feet) from 01/01/02 to 12/31/02.

ENGLISH units

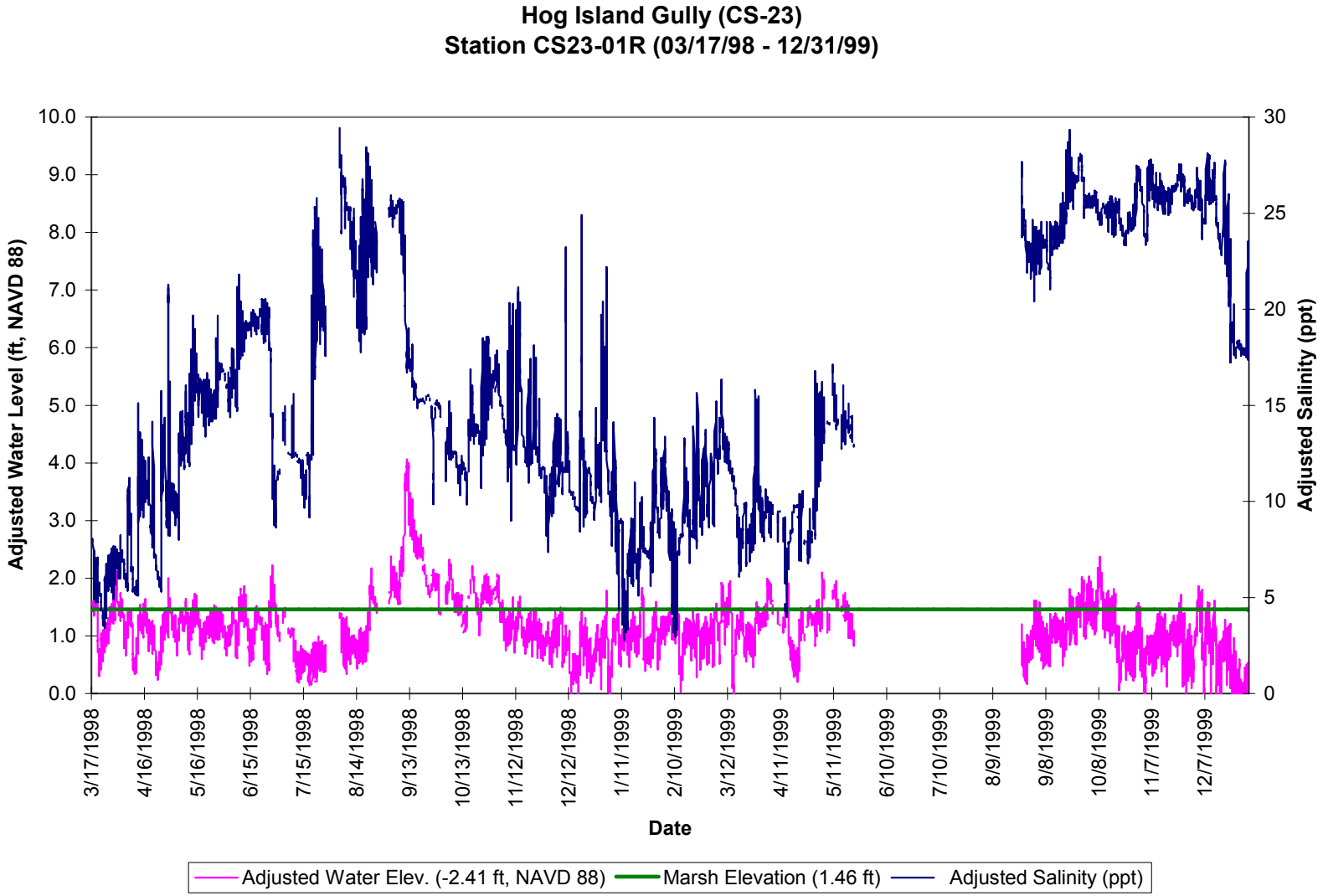


Figure E14. Salinity and water level data from station CS23-01R in (feet) from 03/17/98 to 12/31/99.

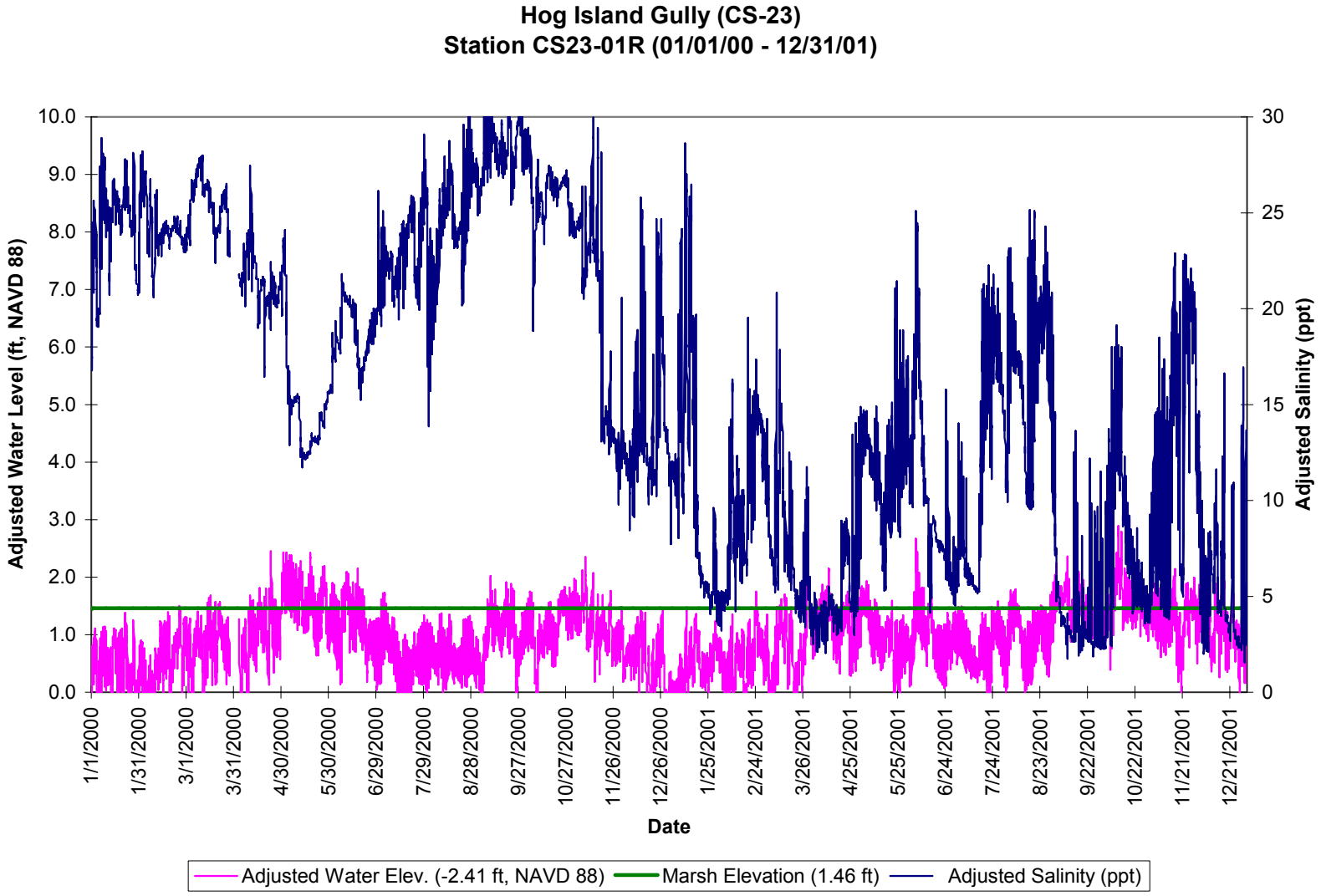


Figure E15. Salinity and water level data from station CS23-01R in (feet) from 01/01/00 to 12/31/01.

ENGLISH units

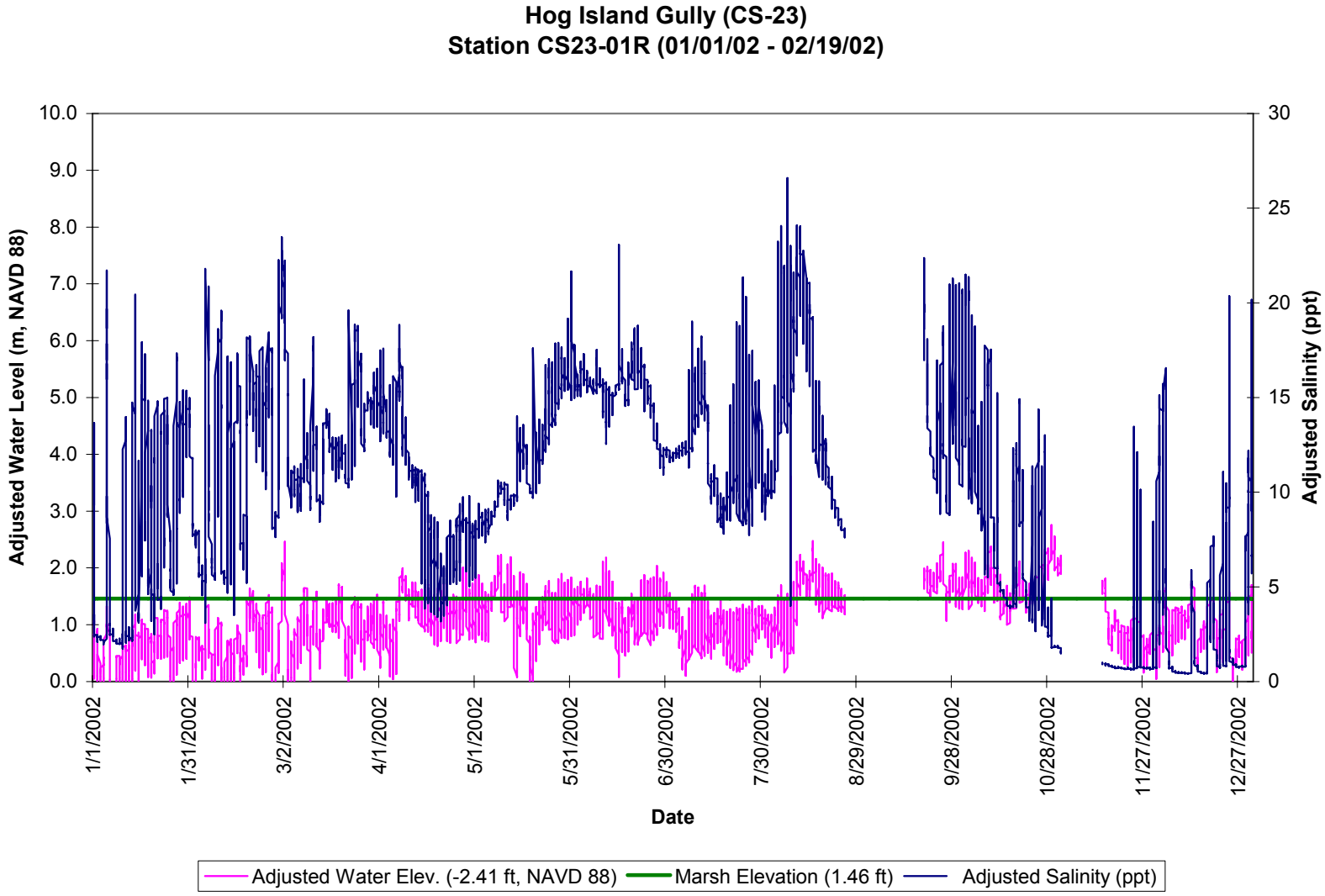


Figure E16. Salinity and water level data from station CS23-01R in (feet) from 01/01/02 to 12/31/02.

ENGLISH units

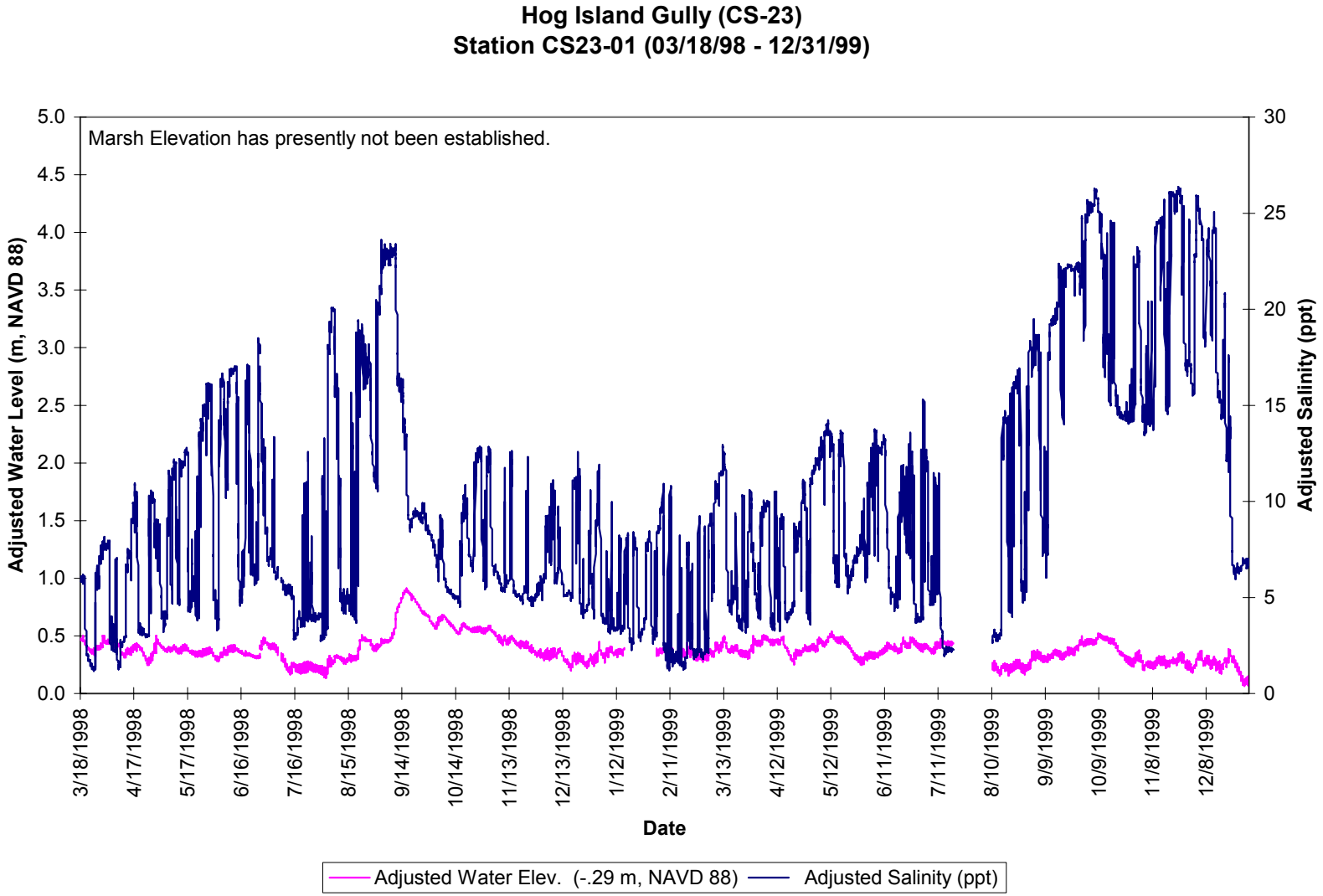


Figure M1. Salinity and water level data from station CS23-01 in (meters) from 03/18/98 to 12/31/99.

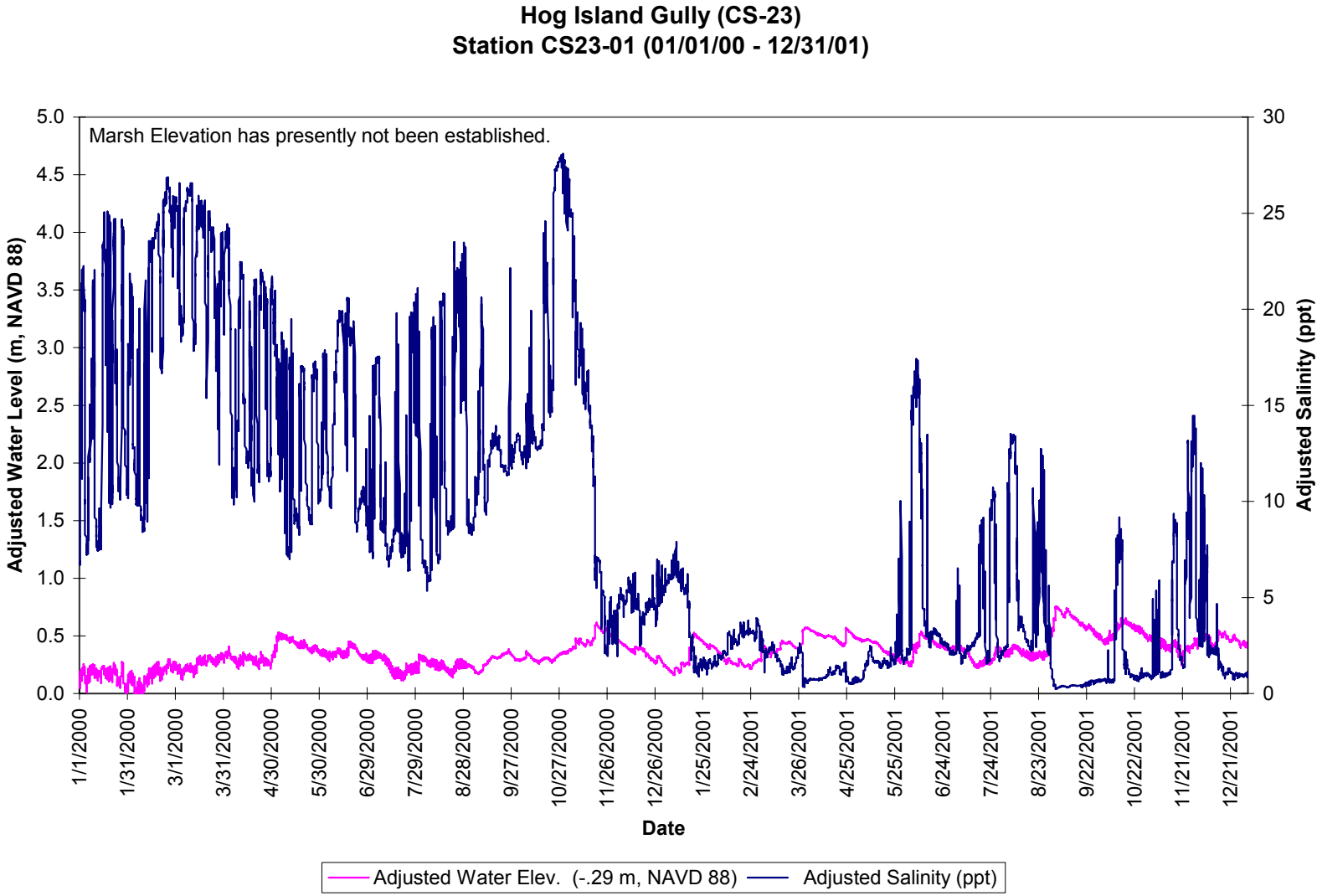


Figure M2. Salinity and water level data from station CS23-01 in (meters) from 01/01/00 to 12/31/01.

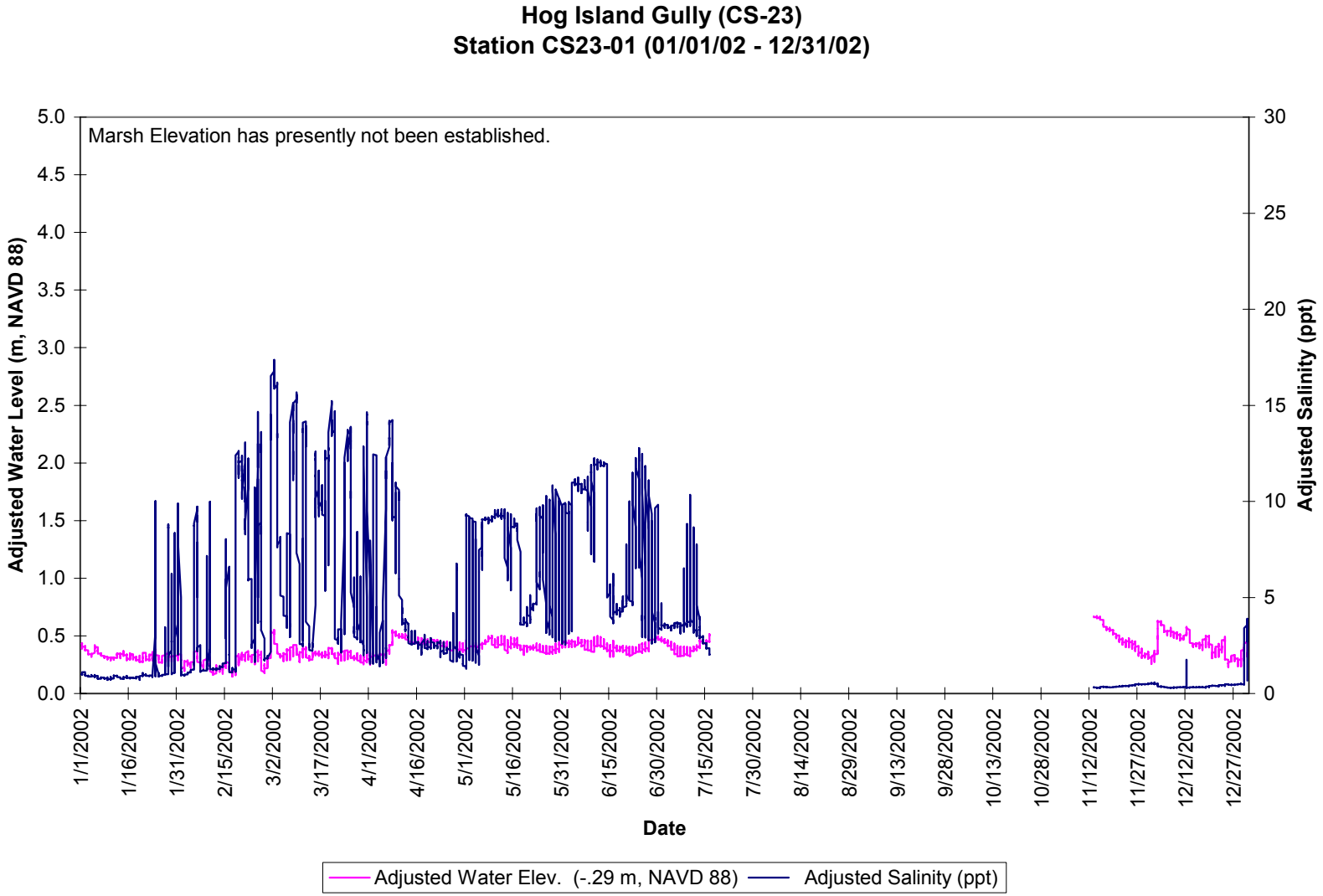


Figure M3. Salinity and water level data from station CS23-01 in (meters) from 01/01/02 to 12/31/02.

METRIC units

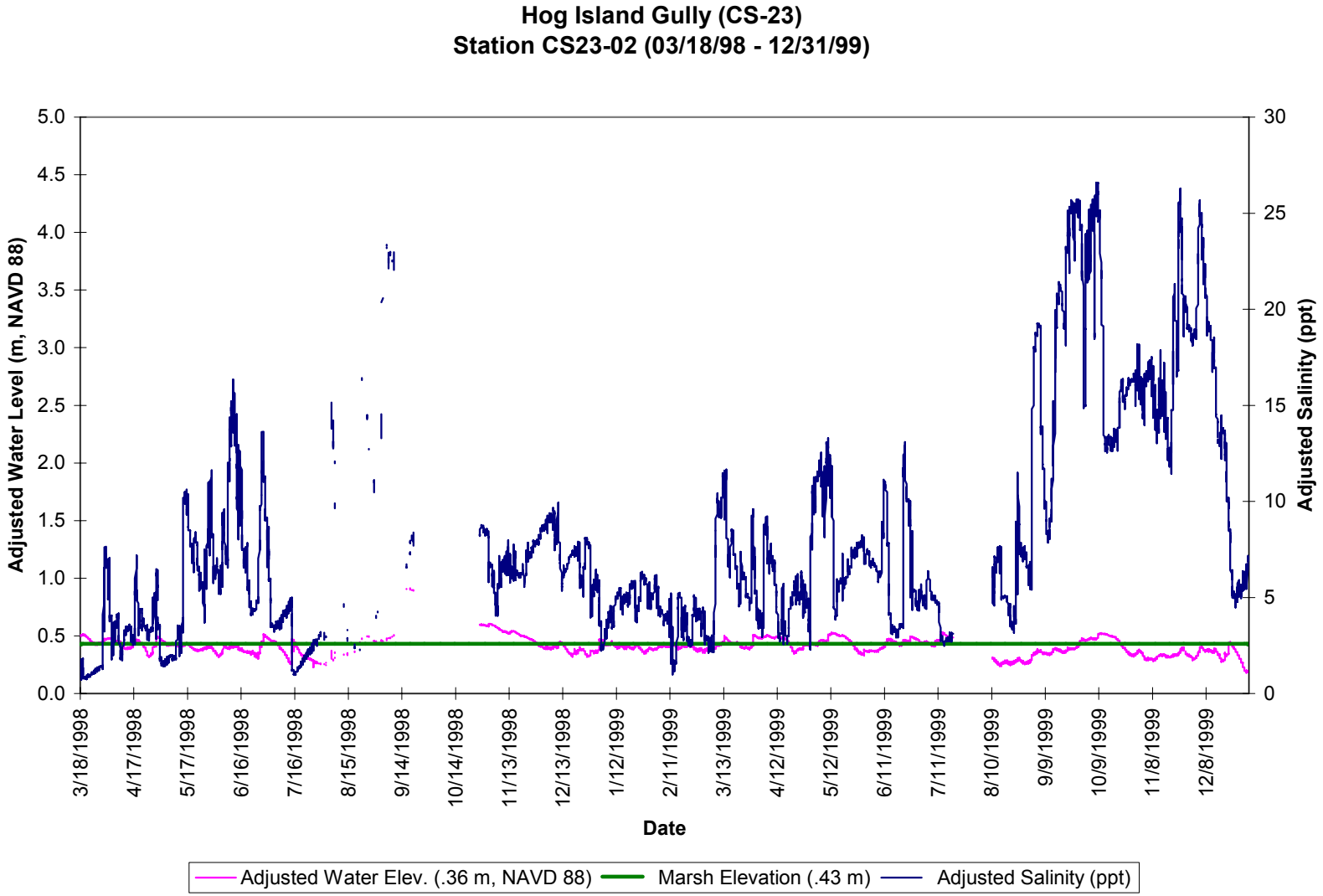


Figure M4. Salinity and water level data from station CS23-02 in (meters) from 03/18/98 to 12/31/99.

METRIC units

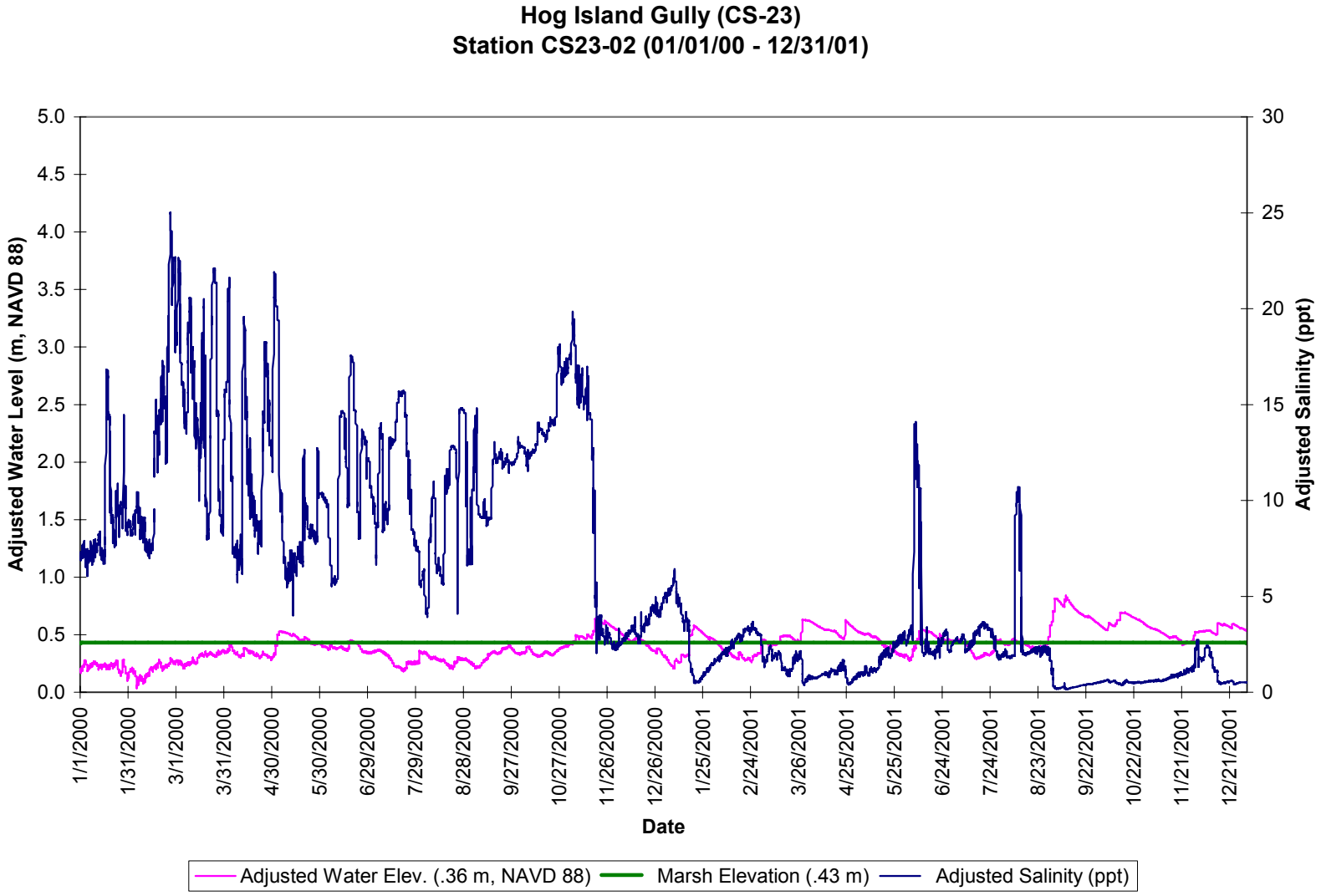


Figure M5. Salinity and water level data from station CS23-02 in (meters) from 01/01/00 to 12/31/01.

METRIC units

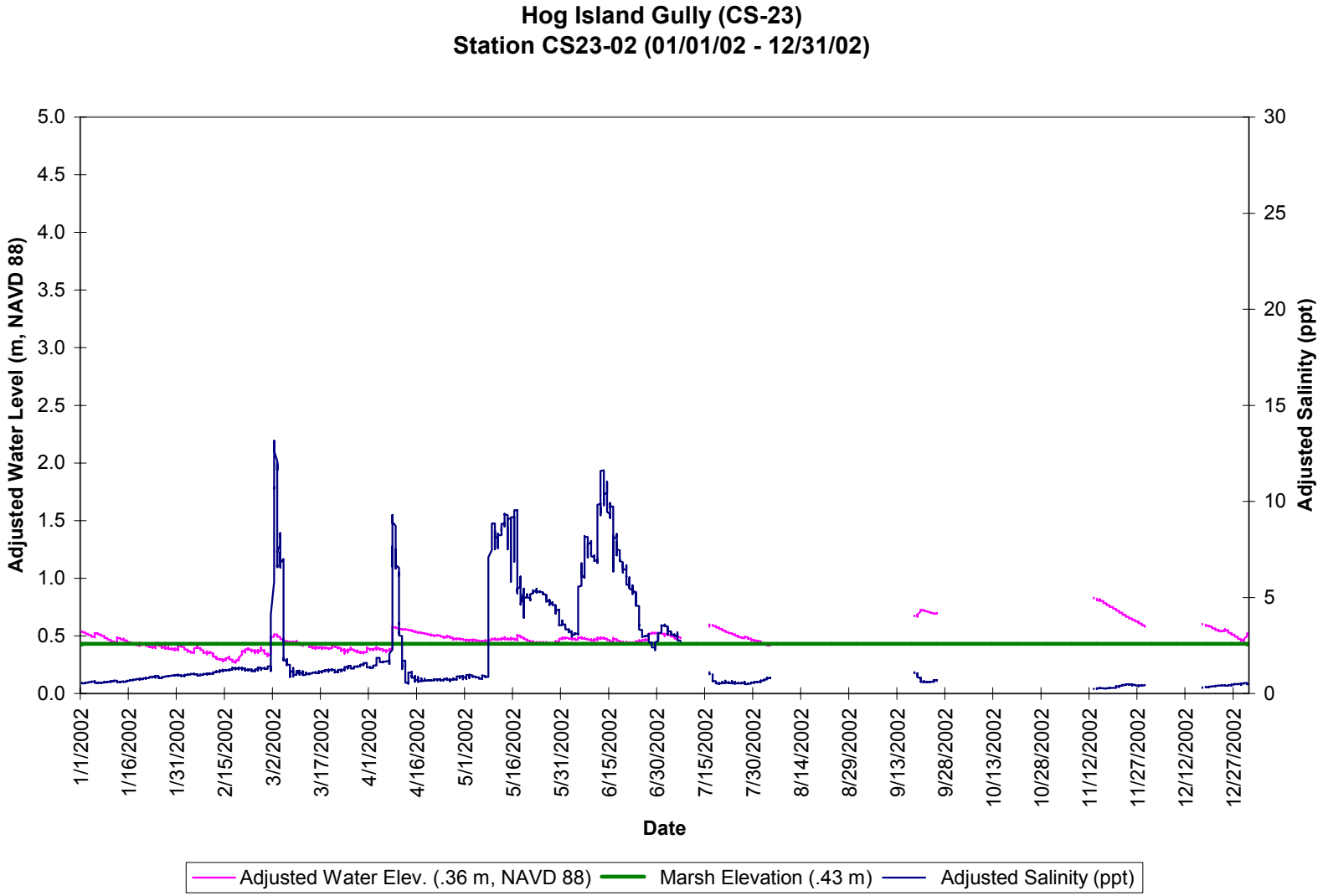


Figure M6. Salinity and water level data from station CS23-02 in (meters) from 01/01/02 to 12/31/02.

METRIC units

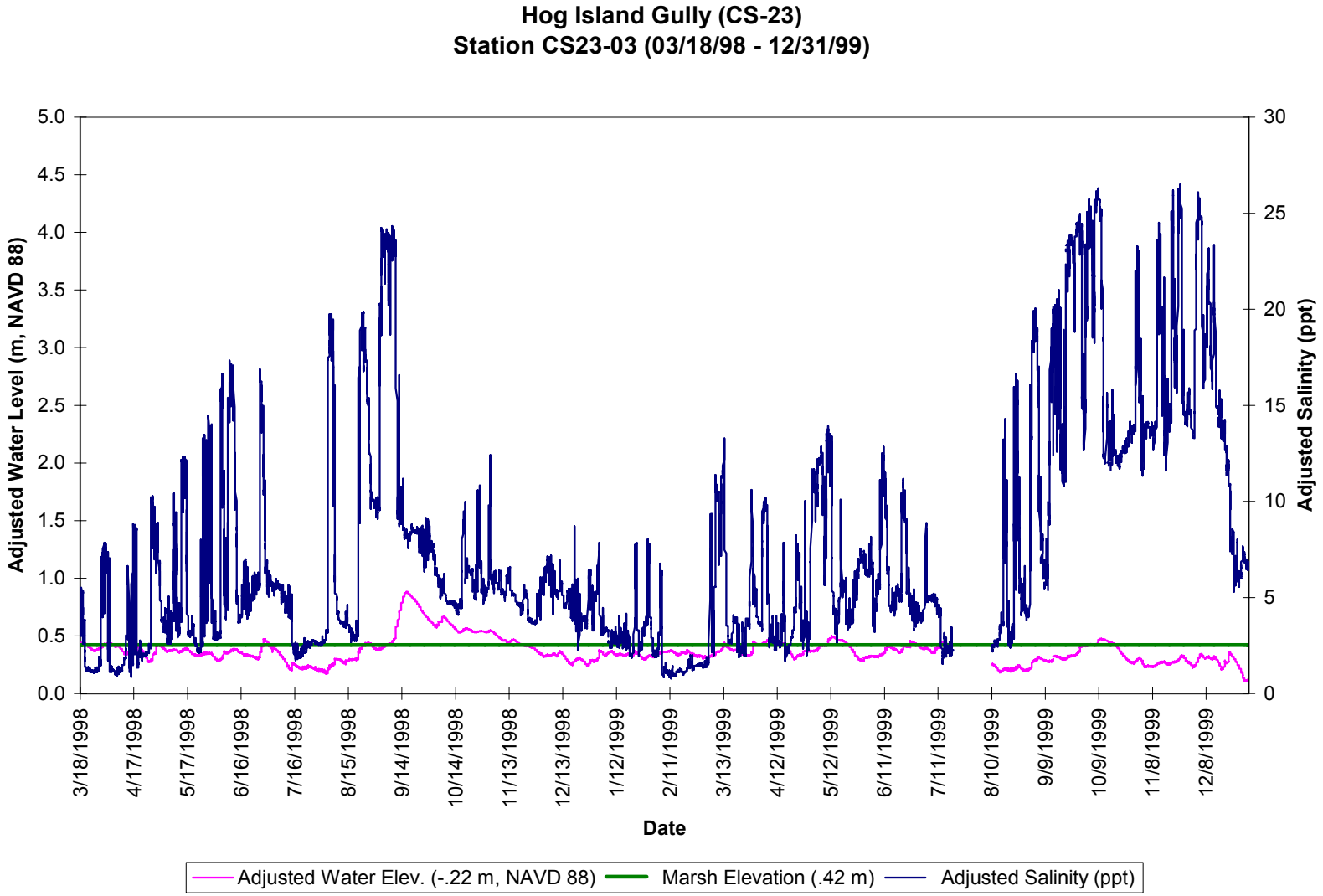


Figure M7. Salinity and water level data from station CS23-03 in (meters) from 03/18/98 to 12/31/99.

METRIC units

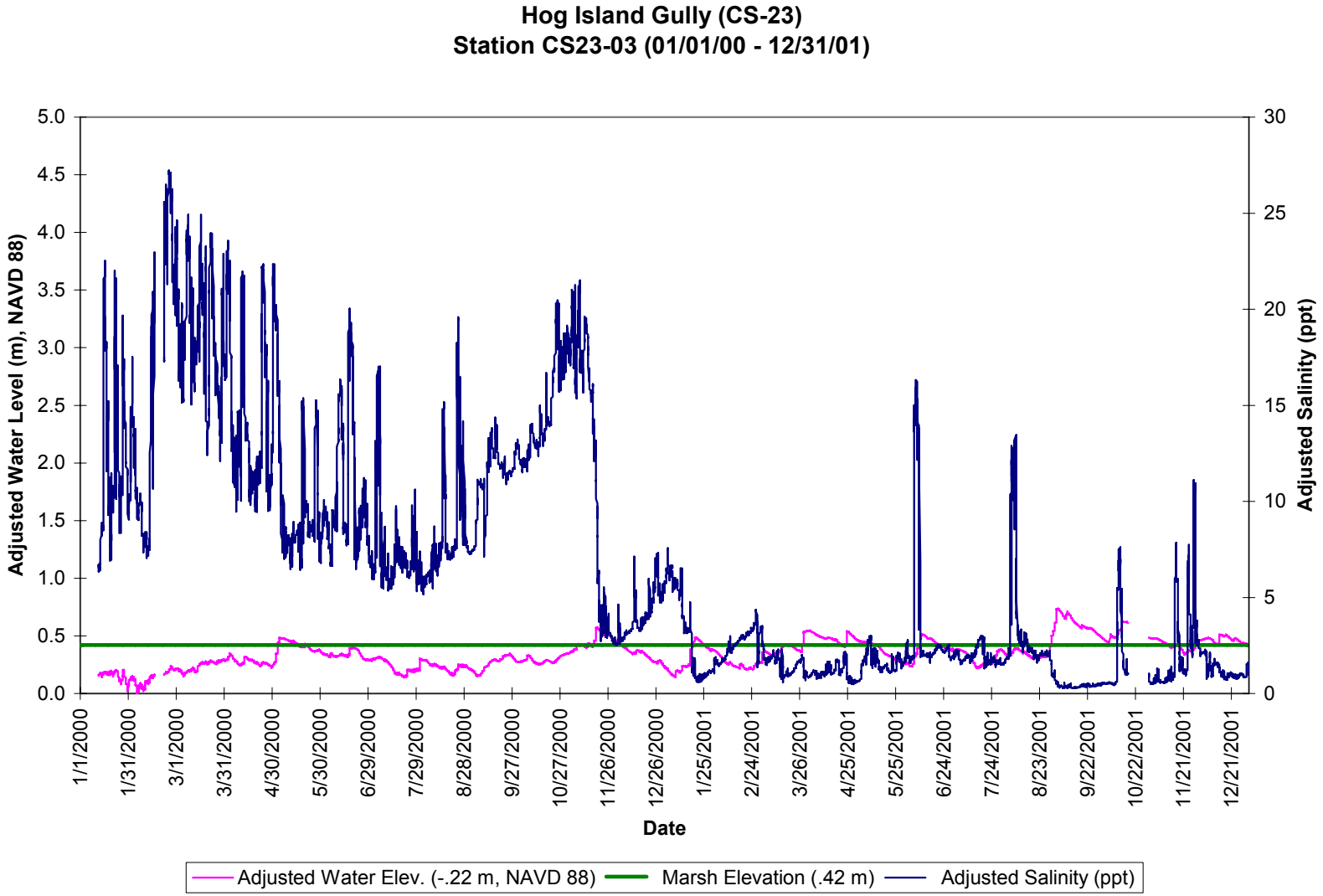


Figure M8. Salinity and water level data from station CS23-03 in (meters) from 01/01/00 to 12/31/01.

METRIC units

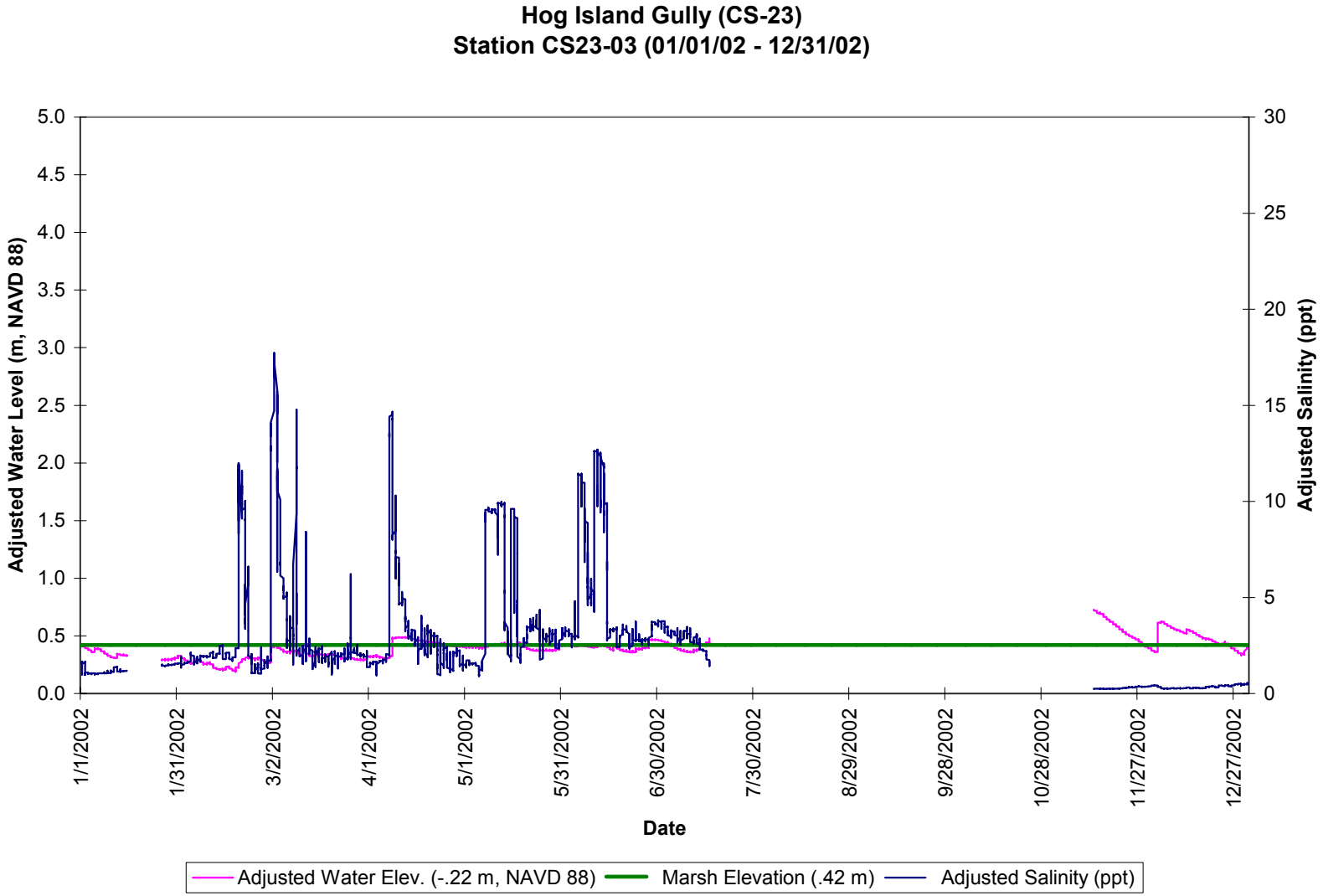


Figure M9. Salinity and water level data from station CS23-03 in (meters) from 01/01/02 to 12/31/02.

METRIC units

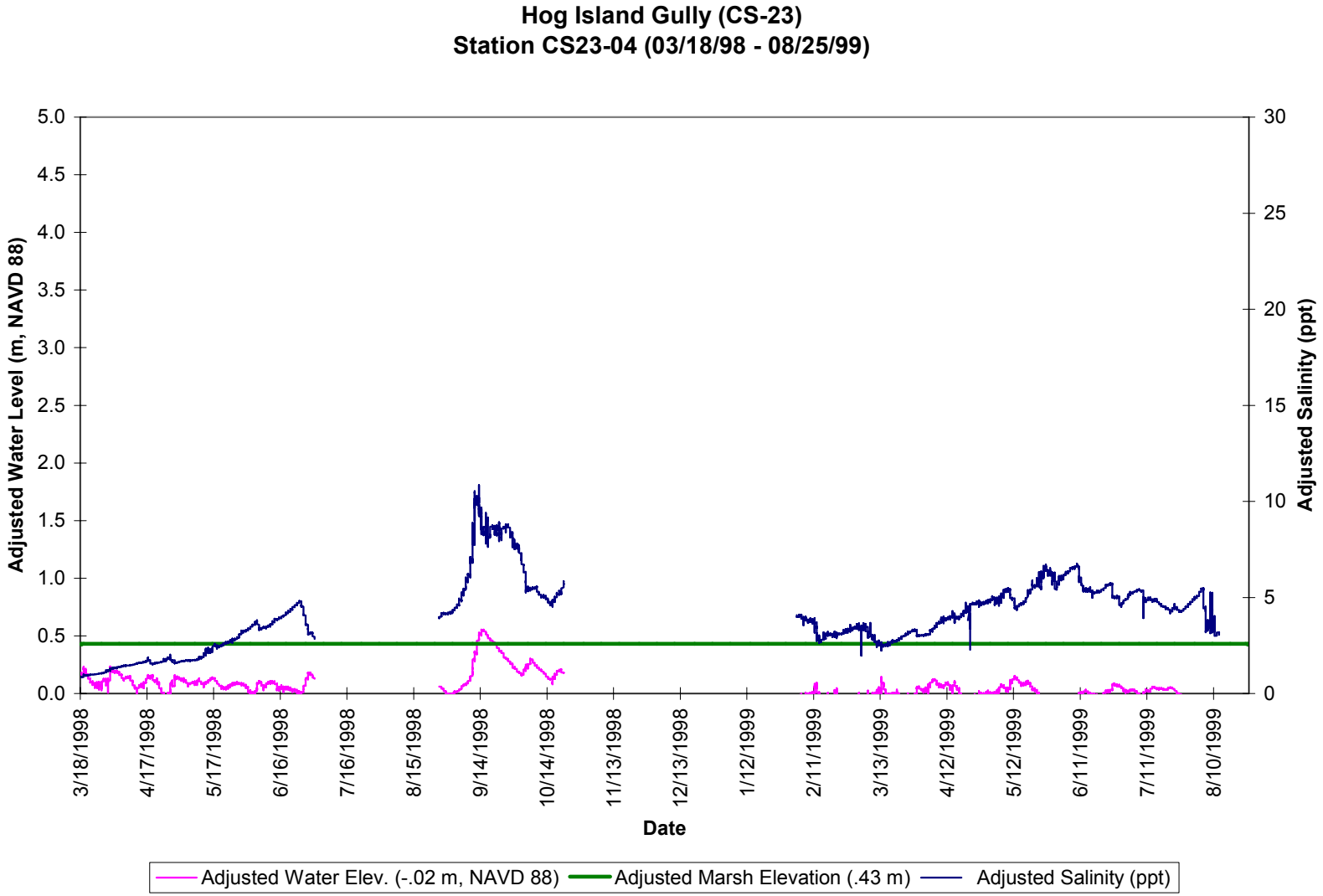


Figure M10. Salinity and water level data from station CS23-04 in (meters) from 03/18/98 to 08/25/99.

METRIC units

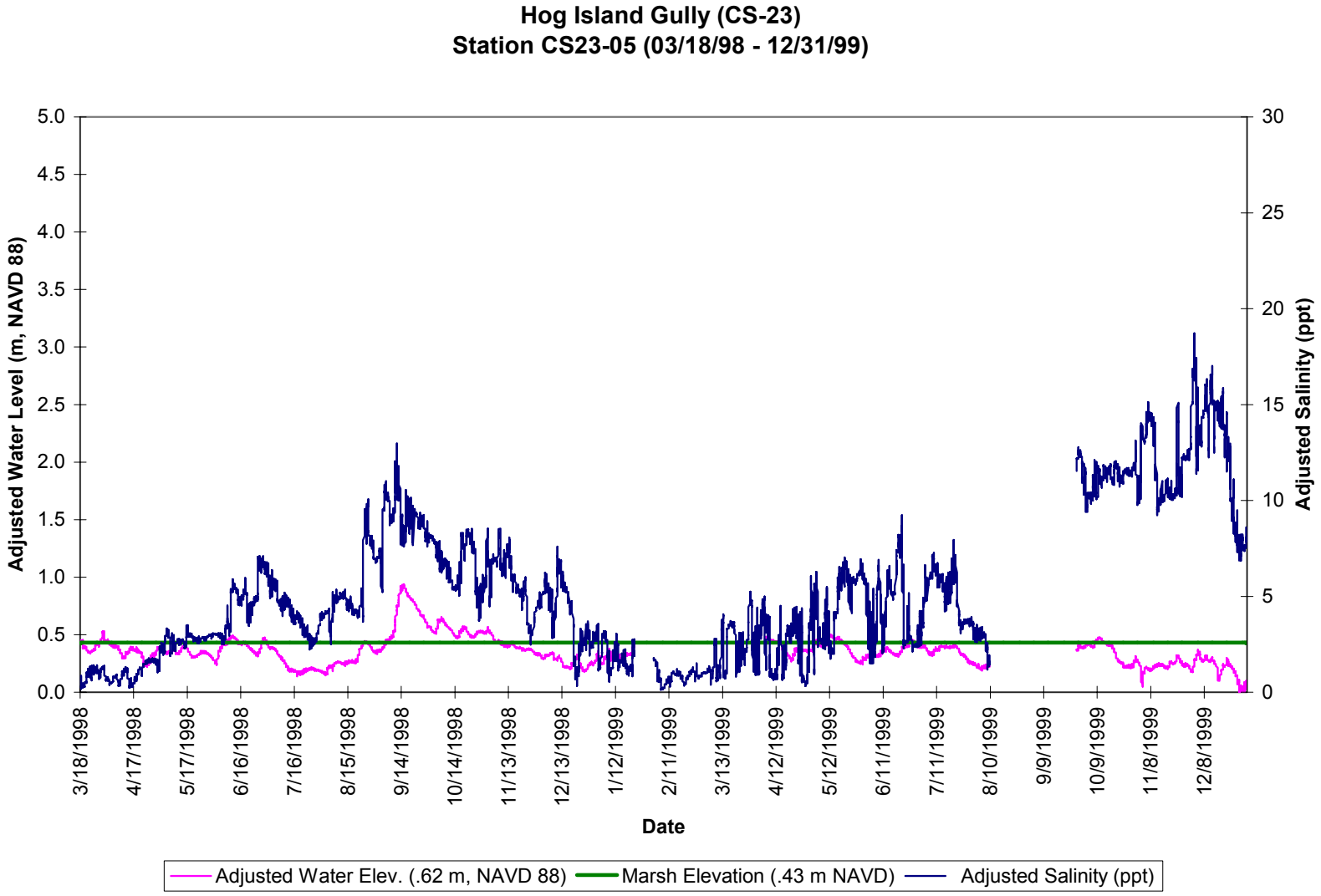


Figure M11. Salinity and water level data from station CS23-05 in (meters) from 03/18/98 to 12/31/99.

METRIC units

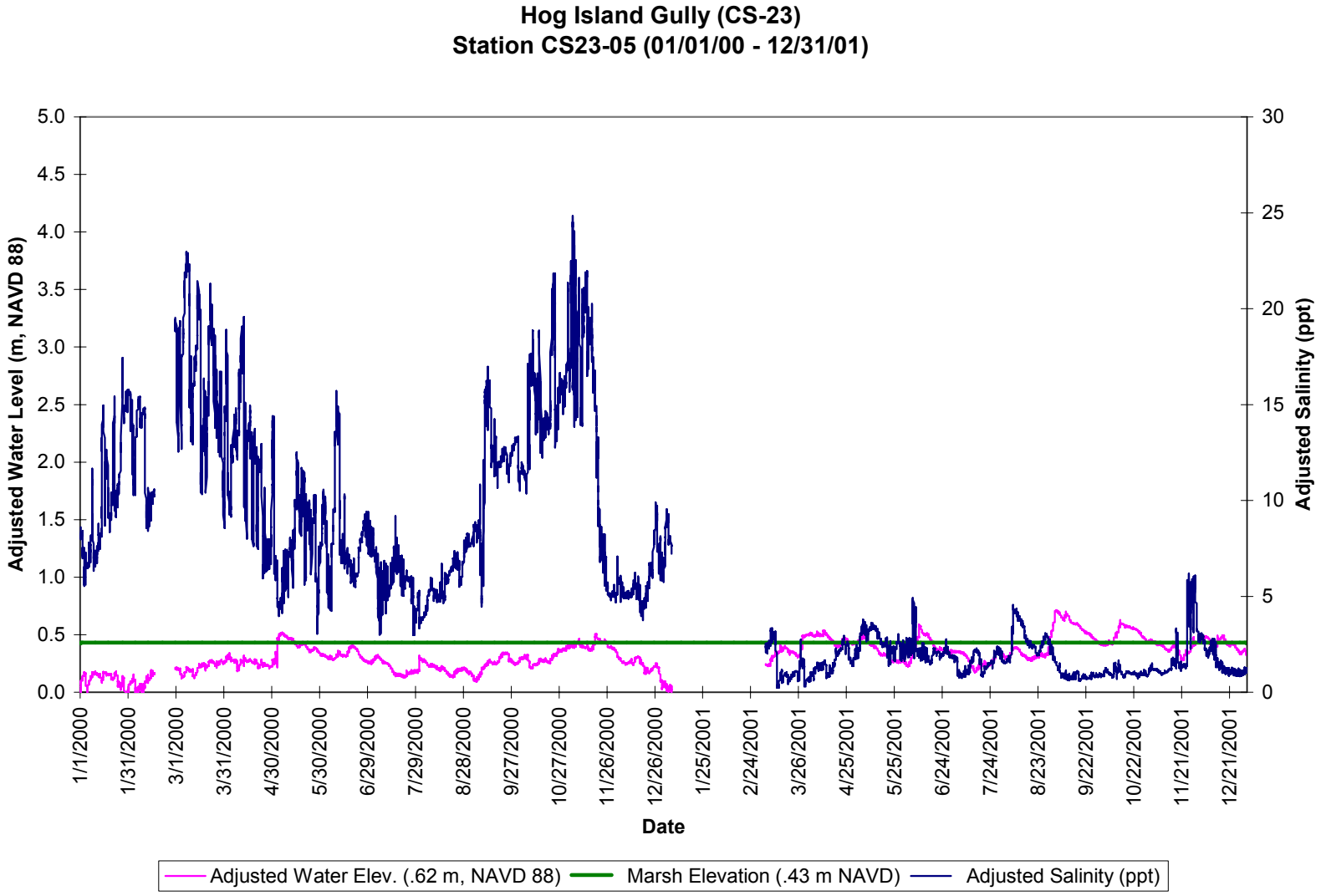


Figure M12. Salinity and water level data from station CS23-05 in (meters) from 01/01/00 to 12/31/01.

METRIC units

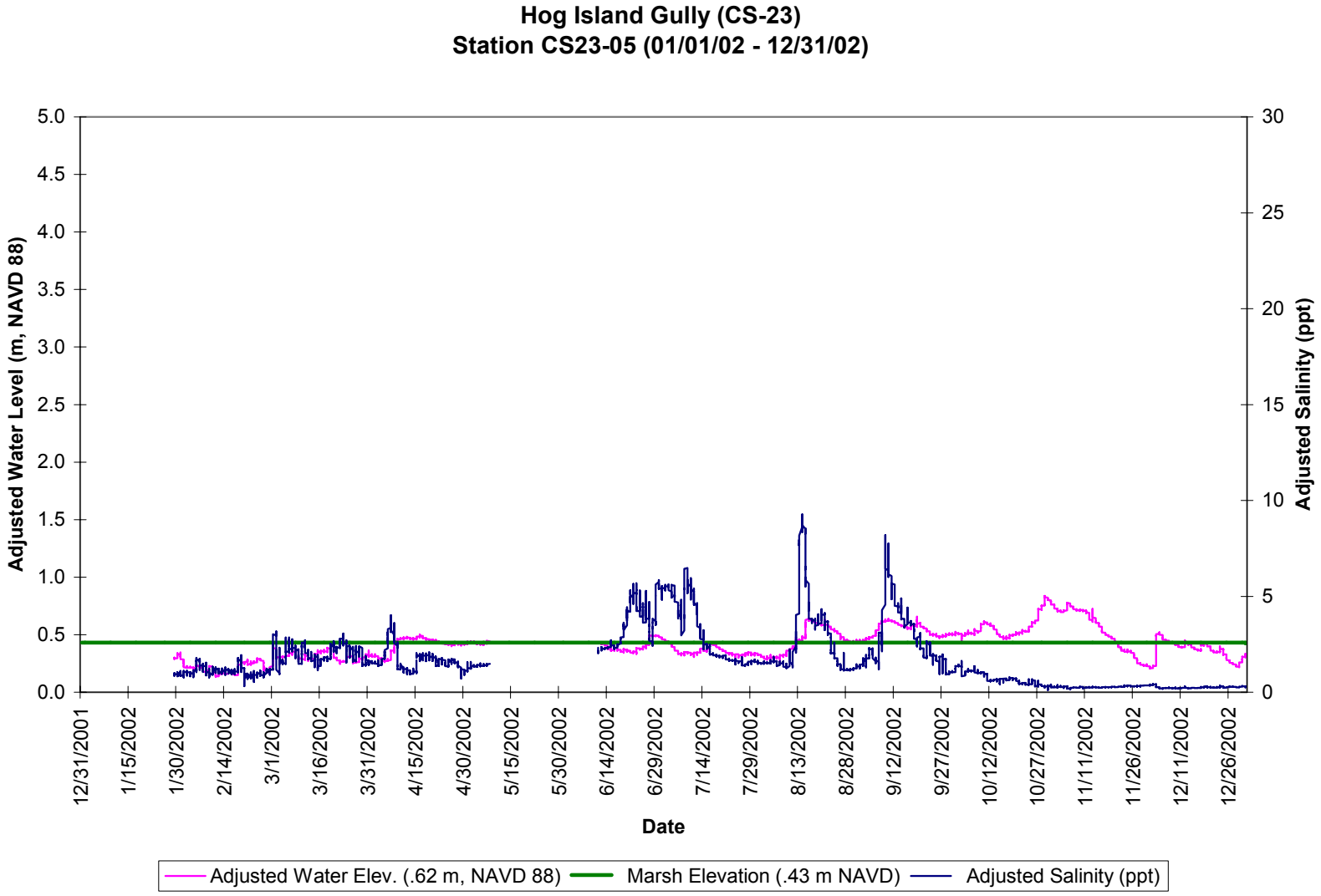


Figure M13. Salinity and water level data from station CS23-05 in (meters) from 01/01/02 to 12/31/02.

METRIC units

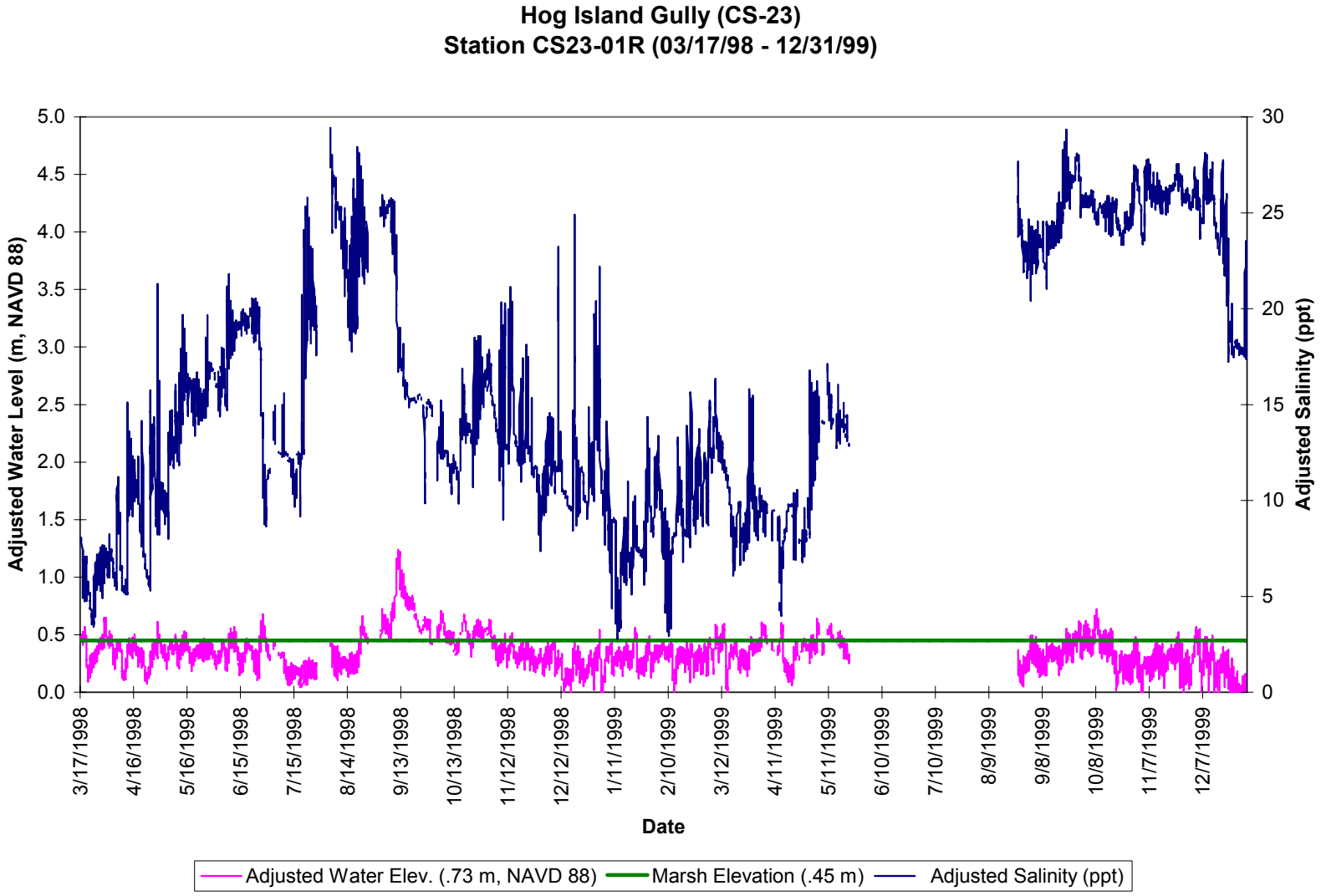


Figure M14. Salinity and water level data from station CS23-01R in (meters) from 03/17/98 to 12/31/99.

METRIC units

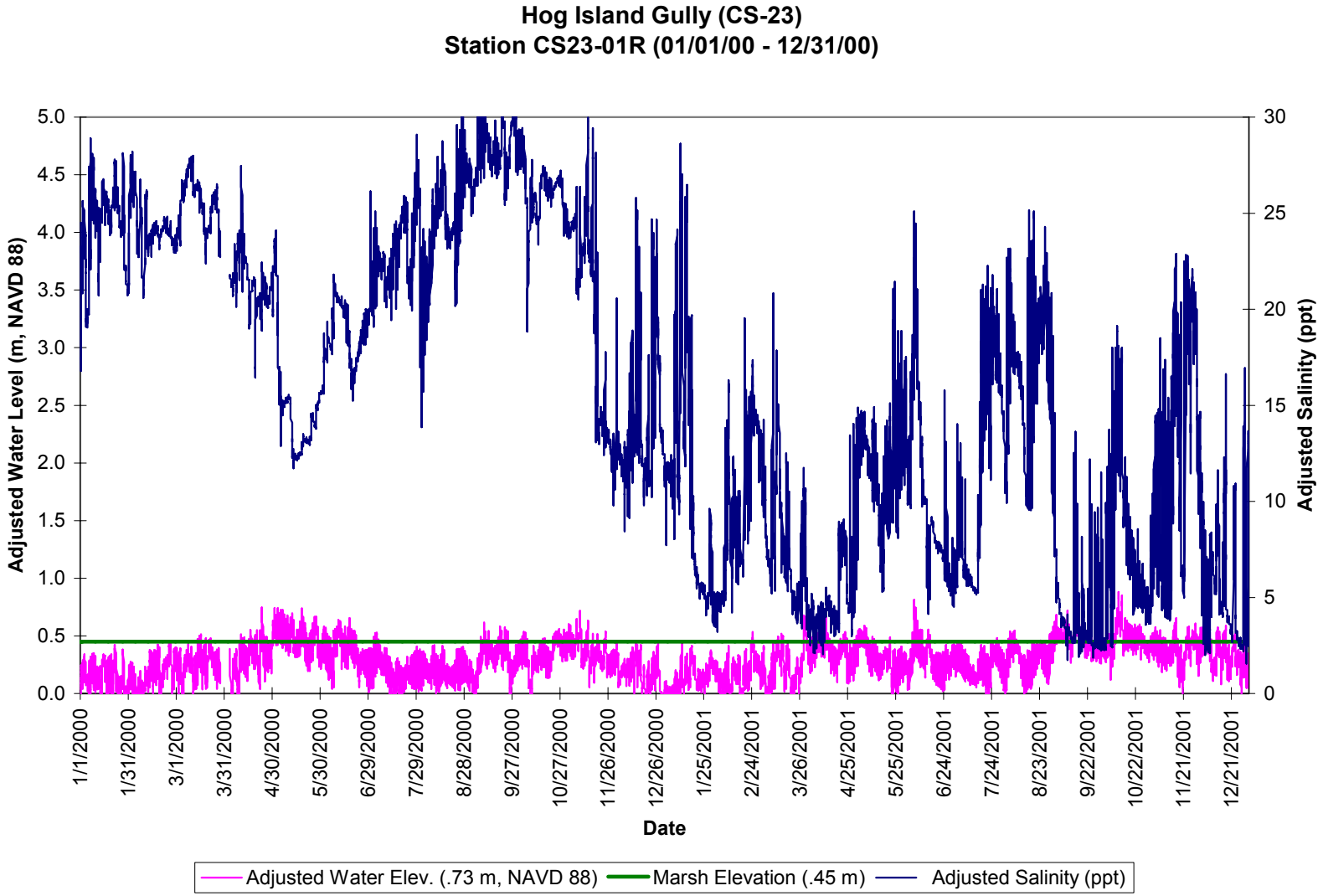


Figure M15. Salinity and water level data from station CS23-01R in (meters) from 01/01/00 to 12/31/01.

METRIC units

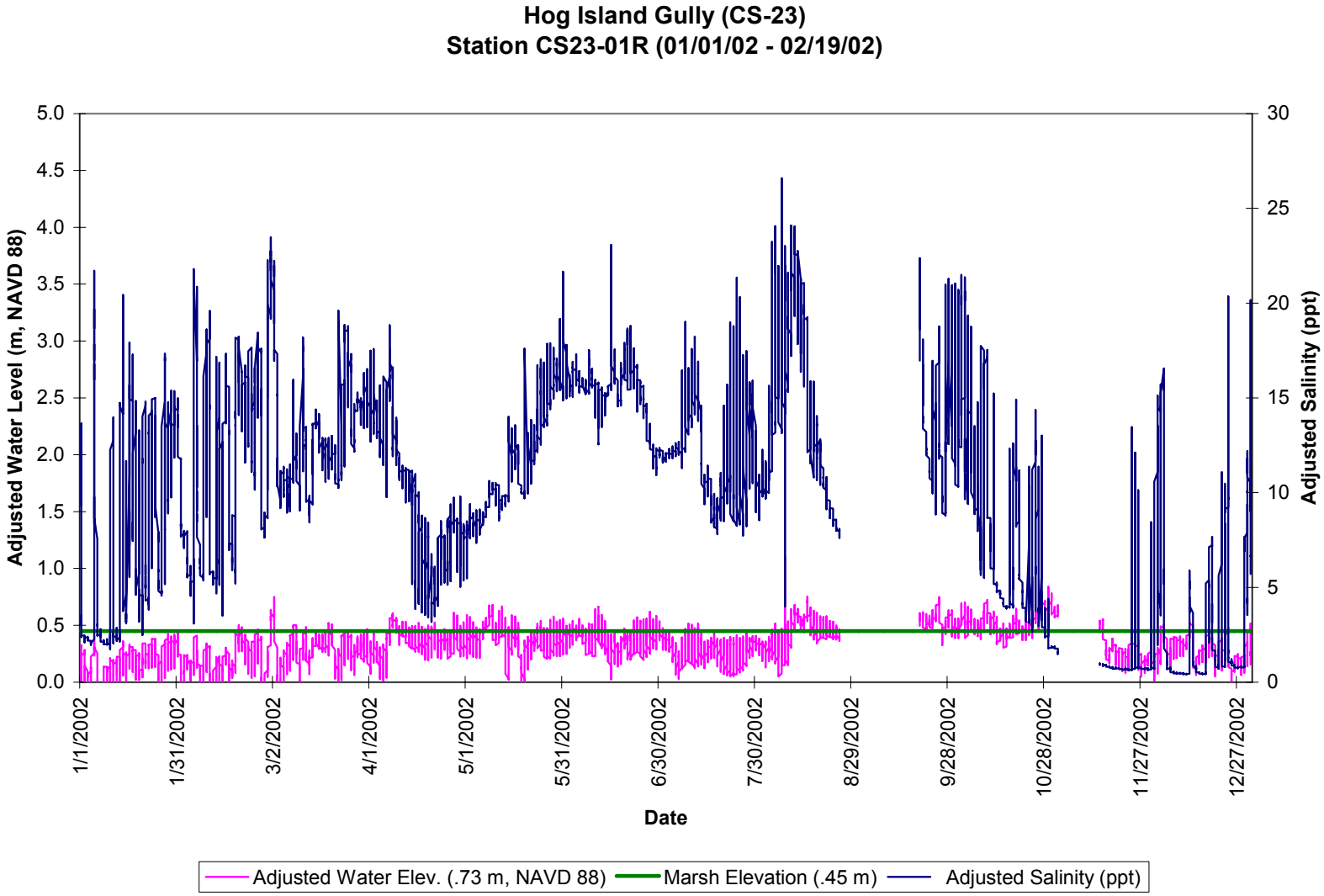


Figure M16. Salinity and water level data from station CS23-01R in (meters) from 01/01/02 to 12/31/02.

METRIC units

Table 2. Least square means of hourly data (inside and outside of the project area) for adjusted continuous salinity and water level data from 1998 to 2002. "In" represents 4 stations within the project area. "Out" represents 1 station located outside of the Hog Island Gully structure.

Year	Adjusted Water Level Least Sq Mean	Std Error
1998 in	1.333	0.003
1998 out	1.275	0.006
1999 in	1.059	0.003
1999 out	1.028	0.006
2000 in	0.969	0.002
2000 out	0.929	0.005
2001 in	1.408	0.002
2001 out	1.054	0.005
2002 in	1.373	0.003
2002 out	1.119	0.005

Year	Adjusted Salinity Least Sq Mean	Std Error
1998 in	6.346	0.031
1998 out	14.022	0.066
1999 in	8.927	0.028
1999 out	17.427	0.064
2000 in	11.701	0.027
2000 out	22.034	0.053
2001 in	2.177	0.027
2001 out	9.620	0.053
2002 in	2.694	0.031
2002 out	10.102	0.055

Hog Island Gully, West Cove & Headquarters Canal Structure Replacement (CS-23)
Emergent Vegetation Data

- Emergent vegetation data was collected in June 1999 at 50 replicate stations
- **Figures and Tables:**
- **Figure 4.** Location of vegetation stations within the Hog Island Gully, West Cove and Headquarters Canal Structure Replacement project area.
- **Table 3**. Mean % Cover and Number of occurrences of emergent vegetation species in the Hog Island Gully (CS-23) project area as recorded in June 1999.
- **Table 4.** Mean % Cover and Number of occurrences (n=100) of the top six emergent vegetation species in the Hog Island Gully (CS-23) project area as recorded in June 1999.
- **Figure 5.** Mean % Cover and Number of occurrences (n=100) of the top six emergent vegetation species within the Hog Island Gully (CS-23) project area as recorded in June 1999.

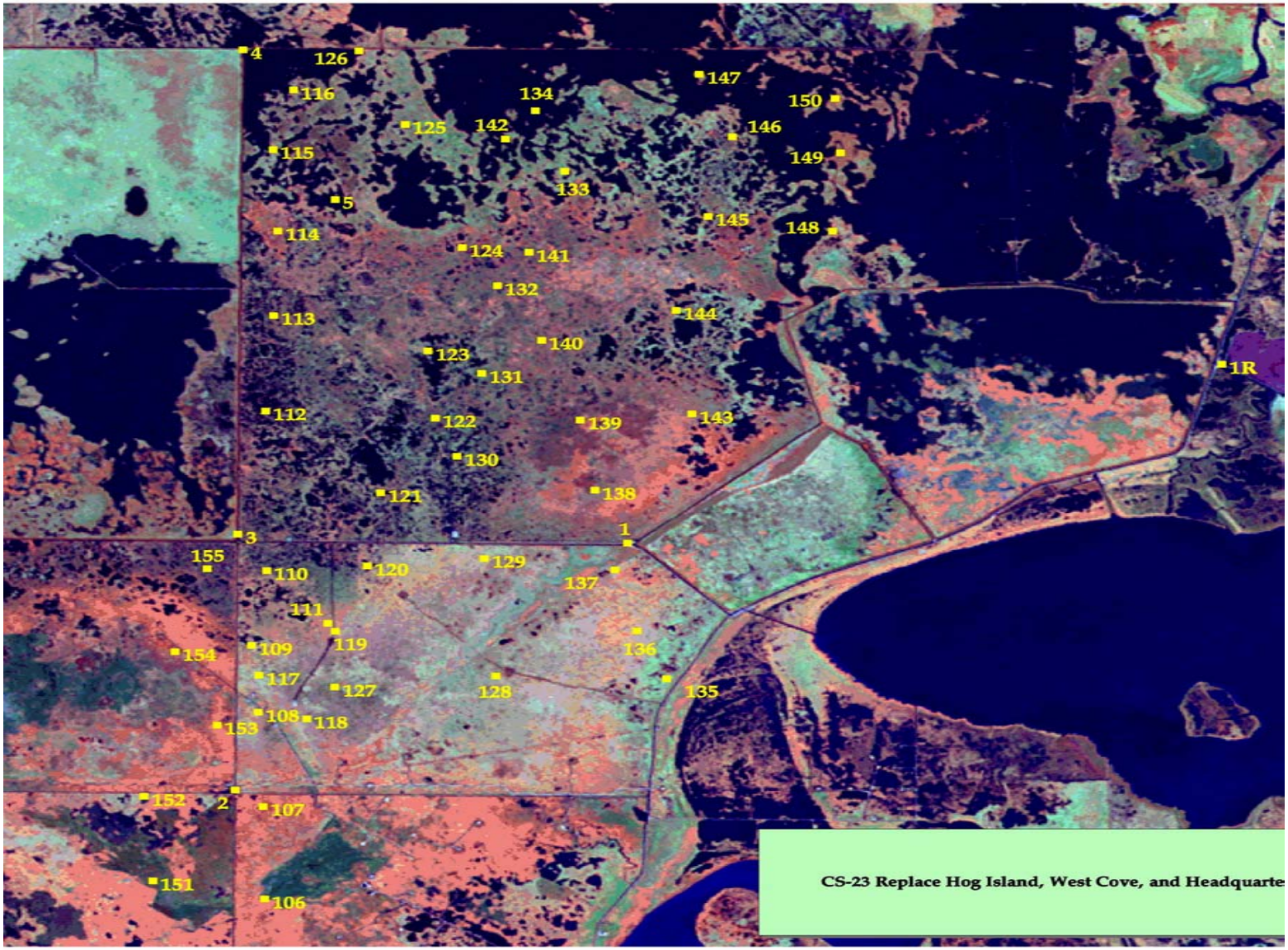


Figure 4. Location of vegetation stations within the Hog Island Gully, West Cove and Headquarters Canal Structure Replacement project area.

Table 3. Mean percent cover and number of occurrences of emergent vegetation species in the Hog Island Gully (CS-23) project area as recorded in June 1999.

Species	Common Name	Mean % Cover (inside) n=100	# occurrences (inside)	Mean % Cover (outside) n=100	# occurrences (outside)
Amaranthus australis (Gray) Sauer	southern amaranthus	0.6175	16	0.815	15
Baccharis halimifolia L.	eastern baccharis	0.055	3	0.2575	7
Bacopa monnieri (L.) Pennell	coastal waterhyssop	0.03	1	0	0
Cladium mariscus (L.) Pohl ssp. jamaicense (Crantz) Kukenth.	jamaica sawgrass	0.3	1	1.4	9
Cyperus erythrorhizos Muhl.	redroot nutgrass	0.08	3	0	0
Cyperus filicinus Vahl	fern flatsedge	0	0	0.4	4
Cyperus odoratus L.	fragrant flatsedge	0.035	3	0.0025	1
Cyperus virens Michx.	green flatsedge	0.0325	2	0	0
Distichlis spicata (L.) Greene	seashore saltgrass	7.89	17	1.15	3
Echinochloa walteri (Pursh) Heller	coast cockspur	0.1	2	0	0
Eclipta prostrata (L.) L.	false daisy	0.2025	2	0.2025	2
Eleocharis R. Br.	spikerush	1.2	2	0	0
Eupatorium capillifolium (Lam.) Small	dogfennel	0	0	0.3	4
Hydrocotyle verticillata Thunb.	whorled marshpennywort	0.025	2	0	0
Ipomoea sagittata Poir.	saltmarsh morningglory	0.44	12	0.5	6
Iva frutescens L.	bigleaf sumpweed	0	0	0.2	2
Juncus roemerianus Scheele	needlegrass rush	0.15	2	0.7	5
Kosteletzkya virginica (L.) K. Presl ex Gray	virginia saltmarsh mallow	0.0025	1	0	0
Nymphaea odorata Ait.	white waterlilly	0.03	1	0.03	1
Panicum repens L.	torpedoegrass	0.05	1	0	0
Paspalum vaginatum Sw.	seashore paspalum	0.12	2	0.05	1
Phragmites australis (Cav.) Trin. ex Steud.	common reed	0.69	4	0.5	3

Table 3 (cont). Mean percent cover and number of occurrences of emergent vegetation species in the Hog Island Gully (CS-23) project area as recorded in June 1999.

Species	Common Name	Mean % Cover (inside) n=100	# occurrences (inside)	Mean % Cover (outside) n=100	# occurrences (outside)
Pluchea camphorata (L.) DC.	Camphor pluchea	0.4925	14	0.05	1
Polygonum hydropiperoides Michx.	Swamp smartweed	0.08	2	0	0
Polygonum L.	knotweed	0.305	12	0	0
Portulaca L.	purslane	0.01	1	0	0
Rumex L.	dock	0.15	1	0.15	1
Schoenoplectus americanus (Pers.) Volk. ex Schinz & R. Keller	Olney bulrush	6.36	14	1.25	8
Schoenoplectus californicus (C.A. Mey.) Palla	California bulrush	3.06	15	0.45	4
Schoenoplectus maritimus (L.) Lye	cosmopolitan bulrush	1.66	7	0.41	5
Schoenoplectus robustus (Pursh) M.T. Strong	sturdy bulrush	1.6	4	0	0
Sesbania herbacea (P. Mill.) McVaugh	bigpod sesbania	0.15	2	0	0
Solidago sempervirens L. var. mexicana (L.) Fern.	seaside goldenrod	0.0525	2	0.05	1
Spartina alterniflora Loisel.	Smooth cordgrass	0.13	2	0	0
Spartina patens (Ait.) Muhl.	Marshhay cordgrass	76.62	90	0.7	4
Symphyotrichum subulatum (Michx.) Nesom	eastern annual saltmarsh aster	0.33	8	0.55	10
Symphyotrichum tenuifolium (L.) Nesom	perennial saltmarsh aster	0.0025	1	0	0
Typha latifolia L.	broadleaf cattail	5.35	25	0.64	13
Unknown	Unknown	0.05	1	0	0
Vigna luteola (Jacq.) Benth.	Hairypod cowpea	0.245	7	0.305	5

Table 4. Mean % Cover and Number of occurrences (n=100) of the top six emergent vegetation species in the Hog Island Gully (CS-23) project area as recorded in June 1999.

Species	Common Name	Mean % Cover	# Occurrences
Spartina patens	Marshhay cordgrass	76.62	90
Distichlis spicata	seashore saltgrass	7.89	17
Schoenoplectus americanus	Olney bulrush	6.36	14
Typha latifolia	broadleaf cattail	5.35	25
Schoenoplectus californicus	California bulrush	3.06	15
Eleocharis radicans	rooted spikerush	1.2	2

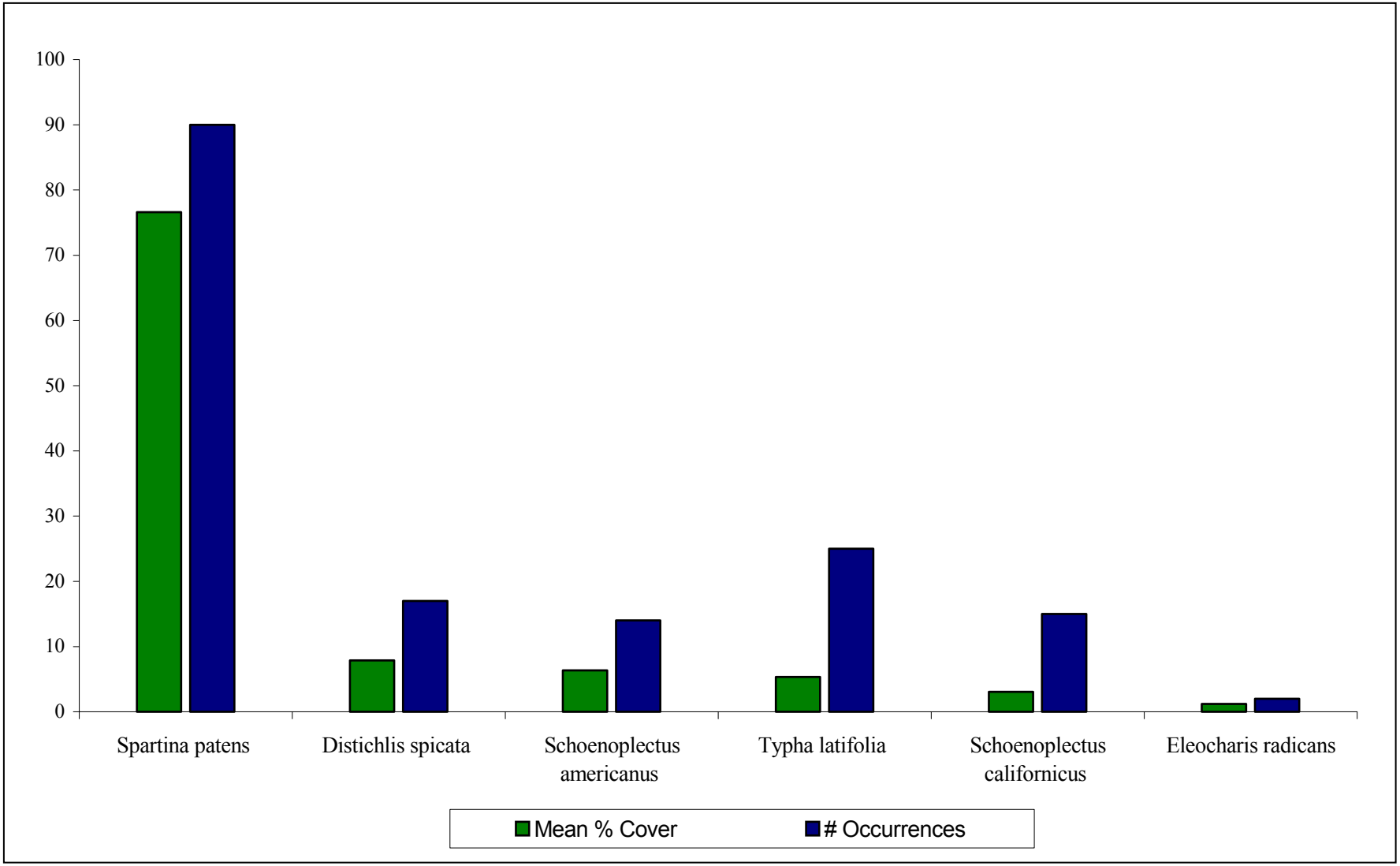


Figure 5. Mean % Cover and Number of occurrences (n=100) of the top six emergent vegetation species within the Hog Island Gully (CS-23) project area as recorded in June 1999.

Hog Island Gully, West Cove & Headquarters Canal Structure Replacement (CS-23)

Submerged Aquatic Vegetation Data

Figures and Tables:

Table 5. Number of occurrences and % occurrences of SAV species within the Hog Island Gully, West Cove and Headquarters Canal Structure Replacement project area.

Figure 6. Number of occurrences and % occurrences of SAV species within the Hog Island Gully, West Cove and Headquarters Canal Structure Replacement project area

Table 5. Number of occurrences and % occurrences of SAV species within the Hog Island Gully, West Cove and Headquarters Canal Structure Replacement project area.

Species	Common Name	# Occurrences Project	# Occurrences Reference	% Occurrences Project	% Occurrences Reference
Ruppia maritima	widgeongrass	65	34	20	14
Unidentified Alga	alga spp.	2	0	1	0
Unvegetated		249	209	78	86
Nelumbo lutea	american lotus	4	0	1	0
Total		**320**	**243**	**100**	**100**

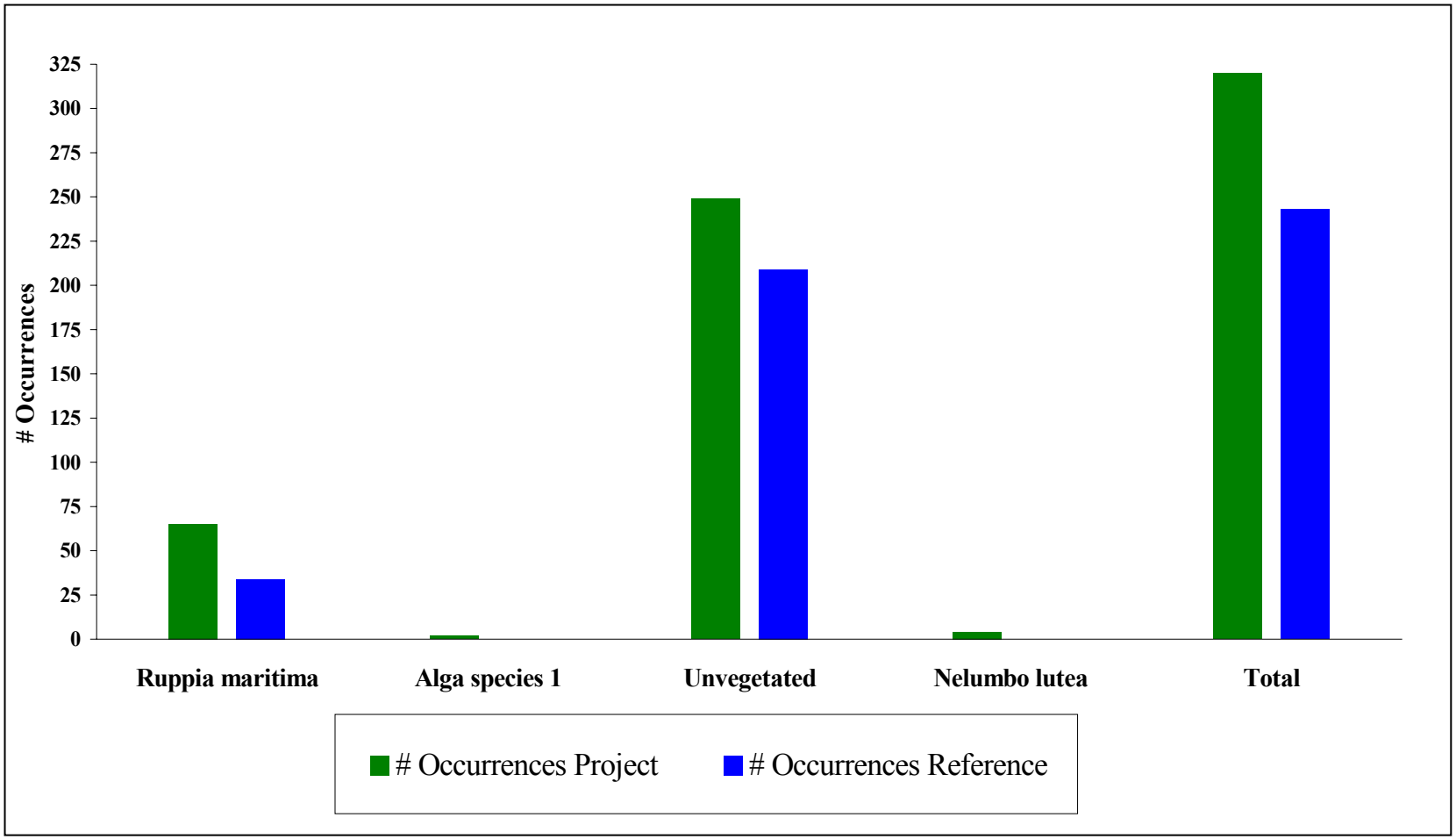


Figure 6. Number of occurrences of SAV species within the (CS-23) Hog Island Gully, West Cove and Headquarters Canal structure replacement project and reference areas.

Hog Island Gully, West Cove & Headquarters Canal Structure Replacement (CS-23)

Preliminary Findings

- **Aerial Photography:** The analyses of pre-construction land/water ratios within the project and reference areas indicate that the project contained 67.47% land to 32.53% water and the reference area contained 57.89% land to 42.11% water. These data will be combined with future land/water analyses to determine land change rates over time.

- **Salinity:** The analyses of continuous salinity data from 1998 to 2002 indicate that salinity each year was lower inside the project area than outside (Table 2).

- **Water Level:** The analyses of adjusted continuous water level data from 1998 to 2002 indicate that water levels each year were higher inside the project area than outside (Table 2). Because the structures have not been operational since construction was completed in 2001, salinity and water level response cannot be attributed to the project.

- **Vegetation:** Preconstruction emergent vegetation data collected in June 1999, indicated that the area is dominated by by *Spartina patens,* which had the highest cover value of 76.62 %. The five co-dominant emergent vegetation species *Distichlis spicata, Schoenoplectus americanus, Typha latifolia, Schoenoplectus americanus* and *Eleocharis radicans* had percent covers of 7.89 %, 6.36 %, 5.35%, 3.06% and 1.20% respectively (Table 4).

- **SAV:** Preconstruction submerged aquatic vegetation data collected in June 1999 indicate that three species, *Ruppia maritima, Nelumbo lutea* and an *unidentified Alga spp* represented the total number of occurrences among all sampling plots inside and outside the project area (table 5).